

kilobaud^{T.M.}

The Small Computer Magazine

ISSUE #10

October 1977

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SWTPC announces first dual minifloppy kit under \$1,000



Now SWTPC offers complete best-buy computer system with \$995 dual minifloppy, \$500 video terminal/monitor, \$395 4K computer.



\$995 MF-68 Dual Minifloppy

You need dual drives to get full benefits from a minifloppy. So we waited to offer a floppy until we could give you a dependable dual system at the right price.

The MF-68 is a complete top-quality minifloppy for your SWTPC Computer. The kit has controller, chassis, cover, power supply, cables, assembly instructions, two highly reliable Shugart drives, and a diskette with the Floppy Disk Operating System (FDOS) and disk BASIC. (A floppy is no better than its operating system, and the MF-68 has one of the best available.) An optional \$850 MF-6X kit expands the system to four drives.



\$500 Terminal/Monitor

The CT-64 terminal kit offers these premium features: 64-character lines, upper/lower case letters, switchable control character printing, word highlighting, full cursor control, 110-1200 Baud serial interface, and many others. Separately the CT-64 is \$325, the 12 MHz CT-VM monitor \$175.



\$395 4K 6800 Computer

The SWTPC 6800 comes complete with 4K memory, serial interface, power supply, chassis, famous Motorola MIKBUG® mini-operating system in read-only memory (ROM), and the most complete documentation with any computer kit. Our growing software library includes 4K and 8K BASIC (cassettes \$4.95 and \$9.95; paper tape \$10.00 and \$20.00). Extra memory, \$100/4K or \$250/8K.

Other SWTPC peripherals include \$250 PR-40 Alphanumeric Line Printer (40 characters/line, 5 x 7 dot matrix, 75 line/minute speed, compatible with our 6800 computer and MITS/IMSAI); \$79.50 AC-30 Cassette Interface System (writes/reads Kansas City standard tapes, controls two recorders, usable with other computers); and other peripherals now and to come.

Enclosed is:

- _____ \$1,990 for the full system shown above (MF-68 Minifloppy, CT-64 Terminal with CT-VM Monitor).
- _____ \$995 for the Dual Minifloppy
- _____ \$325 for the CT-64 Terminal
- _____ \$175 for the CT-VM Monitor
- _____ \$395 for the 4K 6800 Computer

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 _____ \$79.50 for AC-30 Cassette Interface
 _____ Additional 4K memory boards at \$100
 _____ Additional 8K memory boards at \$250
 _____ Or BAC # _____ Exp. Date _____
 _____ Or MC # _____ Exp. Date _____
 Name _____ Address _____
 City _____ State _____ Zip _____



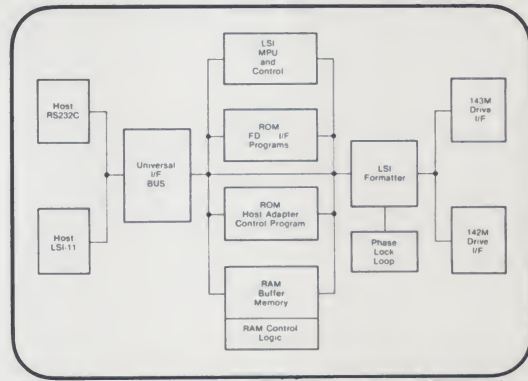
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219 W. Rhapsody, San Antonio, Texas 78216
London: Southwest Technical Products Co., Ltd.
Tokyo: Southwest Technical Products Corp./Japan

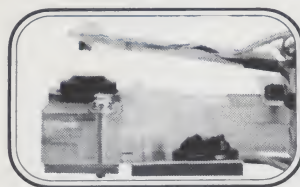
Meet the First Family in floppies.



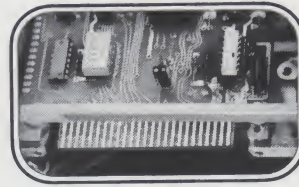
The roots of our floppy family



1143M controller • LSI technology • 1K buffer



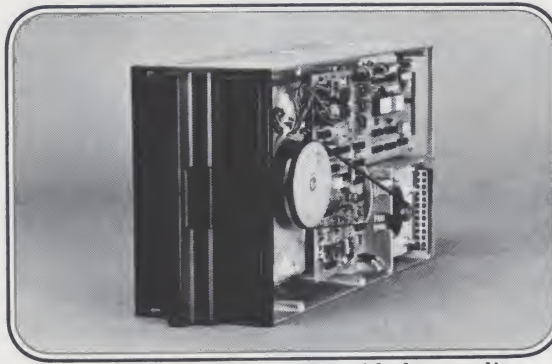
Dual head



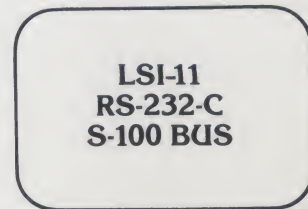
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PUBLISHER'S REMARKS

Wayne Green

Radio Shack

We've been hearing that Radio Shack was working on a microcomputer system for a year or so ... and then there was the hassle over the Computer Shack name with Radio Shack ending up with the name and the Computer Shack franchisers changing to Computerland ... so obviously something was cooking.

Radio Shack has been so aggressive on the low-price end of electronics, with super low-cost CB rigs, audio equipment and radios, that a lot of people figured they would probably come up with something more like a toy than a real computer.

The unveiling of their TRS-80 computer came as rather a surprise to most of the media ... and probably as a severe shock to most of the manufacturers and computer store owners. By now, you probably know the details of the Z-80 - 4K BASIC on ROM, and disk system coming. The plastic molded case is one of the best looking in the field; there is no question that Radio Shack is in there.

The press kit indicated that Radio Shack is not unaware of their low-end image, and that they are trying to overcome this. The TRS-80 should help.

I was so impressed by the system that I borrowed one for a day and used it in making a television commercial promoting Computermania. I wanted something simple to use during the commercial - something attractive. We programmed it to flash the date and place for Computermania on the screen and put the program on a cassette.

The next morning I arrived at the TV studio and

had to let the union people unpack the computer and set it up on a table for me. Love those union rules. I loaded the program and was able to make the commercial quite easily. Those of you around New England may have seen me grinning at the TRS-80 during the evening news.

I hope it is needless to say that *Kilobaud* is interested in your uses of the TRS-80 ... any accessories or mods you come up with for it ... perhaps a match to the S-100 bus? If you write any good programs, let's see those, too.

Shows

After running booths at Cleveland, Atlanta, Seattle and a little affair at Boston University, I'm a bit groggy. None of these pulled in the number of hobbyists I expected, so I'm interested to get an inkling from some of the computerists who weren't too far from a computerfest, but who didn't bother to go ... why?

Each of the shows was well attended, so perhaps I'm just expecting too much. Certainly everyone who went to these shows seemed to be having a good time. Our competitor magazines missed most of the shows, so we've picked up a whole lot of extra circulation on them ... heh, heh.

Business Articles

One of these days we'll have to have a magazine aimed at the businessman - one that will tell him what is available in computers and what they will do for him. This hasn't been practical until now because

there just weren't enough programs around to make business systems practical. Let's try some strictly non-technical articles that will help businessmen understand what microcomputers can do ... how much they will cost ... what is needed in accessories, peripherals and programs ... etc. Until there is a magazine for this market, we'll try to cover it a bit in *Kilobaud* to help out this group.

Computermania

By the time you read this, the show will be over. There's no way to know at this time whether it will be a success or not, but if it isn't it will not be for a lack of trying. It's a lot of work, but it's fun too. If this one works out, we'll be better prepared to do it again and get even more publicity and better advertising.

Naturally we wanted to be sure that we brought in as many exhibitors as possible, so we went to every computer show we could find and talked a lot to all of the exhibitors ... at Cleveland, Dallas, Atlanta and Seattle. Quite a few mailings were sent to prospective exhibitors. In general, most of them were cooperative. A few waited until the last minute and tried to talk the price down, etc.

To bring in the hobbyists, we ran ads in 73, *Kilobaud*, *Personal Computing* and *Interface*. We backed that up with posters in all of the computer stores and in all of the eastern ham distributors. Then we sent an eight-page brochure to every known hobbyist in the eastern part of the country ... about 50,000 of them.

In order to get more hobbyists, we went the route of ads on a couple of the rock radio stations plus ads in two of the major underground newspapers, which reach just about every student in greater Boston.

To reach the businessmen we ran ads in *U.S. News*, *Newsweek*, *Time*,

Boston Magazine, *The New Englander*, *The Boston Globe*, etc. Then we went for them via drive-time radio on several stations and spots on several TV stations around the 7-8 pm slot. We backed that up with taxicab roof posters and as many talk shows as I could get to during the last few days before the show.

The Boston Commonwealth Pier is the largest exhibition facility in New England; still it's possible that it might get filled if our advertising and promotion is able to get the word out to the general public about microcomputers. On the other hand there is always the fear that show time will come and only a handful of people will wander in to see it. This happened just recently at one of the computer shows ... dozens of people came ... it was a disaster.

The Atlantic City computer show's occurring the same weekend has not helped things much ... nor has it hurt a lot as far as exhibitors are concerned. Those who are big enough to handle both are doing that, and those who are too small to manage both are in almost all cases coming to Boston. The only major exception is Heath, which is admittedly a disappointment.

I'd feel worse about Heath's missing Boston if it weren't for the new Radio Shack computer. Heath's absence will undoubtedly help make the Radio Shack system a much bigger success - otherwise the new Heath line, which is quite impressive, might take away from the Radio Shack system.

The basic purpose of Computermania was to put on a big show for businessmen and get them acquainted with microcomputers.

It would have been helpful if we had started a little earlier on advertising and publicity for the show - it's a tough grind writing radio commercials for rock audiences, then another

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EDITOR'S REMARKS

John Craig

BASIC Timing Comparisons — Update

In this month's issue we've got the long-awaited followup article by Phil Feldman and Tom Rugg on timing comparisons between the many popular versions of BASIC on the hobbyist market. We haven't had an article that generated this much interest in a long time.

Heath was a little late in getting the benchmark results for their Benton Harbor BASIC in for the article ... but they did just make it. Next month we're hoping to have an article on benchmarks by one of the Heath Software Engineers, Gordon Letwin.

The DataSync Mess

Several months ago, there was an absolute flood of full-page and double-page ads for DataSync Corporation in Santa Maria CA appearing in the leading computer hobbyist publications. The products being advertised were those that a lot of people would be interested in ... at prices that were hard to beat. As things turned out, the man responsible for the ads and formation of the company was arrested by detectives of the Santa Maria police and agents of the FBI. He has been charged with grand theft under false pretenses and held under \$100,000 bail. Norman Henry Hunt, Jr., age 45, was booked under the alias and identity he had assumed since moving to Santa Maria in October of last year: David W. Winthrop, Colonel, USAF Ret., age 38. The FBI later identified him as Hunt.

The products that were presented in those beautiful ads simply didn't exist. The DS-100 Video Terminal (which I saw in the detective's office) was a total mock-up with nothing inside. As a matter of fact, it was kind of pathetic ... the knobs and keyboard weren't even fastened down ... everything was just lying in place. The police recovered a Polymorphics analog-to-digital board which had been doctored up to look like a "DS-Monitor Board." (You really should be looking at page 44 of *Kilobaud* #8 during this discussion!) They also recovered an S. D. Sales 4K memory board, which was used for the photograph of the "DS-16K RAM Memory Board."

Since his arrest, "Colonel Winthrop" has pleaded guilty to the charges against him. He recently filed a motion to have that plea changed, and a hearing has been scheduled by the court to consider it. (I've been told you have to have rather substantial evidence or considerations in your favor to effect such a plea change.)

Karen Amarillas, the secretary/receptionist at DataSync, has a rather unusual message to read over the phone when you call to inquire about the products they've been advertising.

As soon as you have your hello out, and have indicated you're interested in one of their products, she politely cuts you off and asks to be allowed to read the following:

"I must inform you that the DataSync Corporation advertisements currently appearing in the magazines are fraudulent and the man responsible is now in jail. We do have every intention of producing a 16K RAM and a low-cost video ter-

минаl that are similar electronically and cosmetically, but you do have to be aware that the advertisements are false.

"Our expected shipping date for the new DataSync DS-16K RAM is approximately July 28th, and the expected shipping date on the DA-100 Terminal is September 15th. Knowing this, would you still like to place an order for superior products from DataSync Corporation?"

Karen, and everyone else at DataSync, was quite apprehensive about the idea of reading this message to prospective customers. The apprehension has since turned to surprise at how well people respond to it. Most of them have gone ahead with placing, or retaining, an order and in addition have wished the people at DataSync success and good luck in coming out from under this mess they find themselves in.

When I decided to do this editorial on DataSync, there was one question foremost in my mind. That is, how did "Dave Winthrop" manage to con the five other people in the company. It's one thing to go out and buy double-page color ads in all the top magazines and fool 50,000 computer hobbyists ... but how did he do it to the people in his own company? I've known Winthrop (we were good friends at one time), so I already had some ideas as to how he pulled it off. I wasn't too surprised when I got the details and found out just how smoothly he had done it.

The length of time the people were with the company, and keeping them separated, were the two main ingredients in his formula. There are four other partners (officers, actually) in DataSync, and three of them didn't come until about a month before Winthrop was arrested (July 1st). Ron Waffle (president) was working for the company down in Santa Barbara for a couple of months. He was preparing to move up to

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LEGAL BUSINESS FORUM

Ken Wideltz
Attorney at Law

The power to pass legislation regulating the organization of those entities we commonly refer to as clubs is a power that is vested solely in the various states, as opposed to the federal government. As a result, the body of law that controls the formation and existence of clubs is by no means uniform. Some states have a comprehensive integrated scheme, while others have a few pertinent rules scattered throughout the state's statutes. Thus, it is impossible to present a step-by-step "cookbook" approach to the formation of a club. This forum is intended to give the potential founding fathers of a club an overview of the areas that will require consideration.

Actually, even in the comprehensive statutory schemes there is no use of the word "club." Rather, if there is a statutory provision, it usually makes reference to educational, charitable, scientific, political or religious organizations. In general, there are two organizational forms that a club can take. One is the unincorporated association and the other is the nonprofit or not-for-profit corporation.

Unincorporated Associations

Unincorporated associations are less formal organizations than nonprofit corporations. In some states, the unincorporated association is not viewed as a legal entity. That is, it cannot sue or be sued in its own name, cannot hold title to

property in its own name and, in a few instances, cannot contract in its own name.

In practice, many unincorporated associations come into existence as ongoing organizations out of informal meetings of their members. They tend to govern themselves based upon informal oral agreements. While many states do recognize such unincorporated associations as legal entities even without the preparation or filing of a constitution, articles of association or charter, the failure to use a written document results in many uncertainties and inevitable disagreements among members. By the way, the terms articles of association, constitution or charter refer to the same thing. By whatever term you call it (or your particular state calls it), it is the contractual agreement among the original members of a club, to which new members also agree. It sets up the general plan of organization and the purposes and methods of operation of the club. It is important that it be written in order to avoid misunderstandings among members as to the management of the organization, requirements for membership, voting, changing the bylaws, etc.

The articles of association follow no particular form. They simply state an agreed plan for the organization and operation of the club. It should be remembered that certain provisions such as those relating to the powers of the organization, the requirements for quorums and the number of directors are in some states specifically regulated by

statute. For that reason, an attorney should be consulted prior to drafting the articles of association. He will be able to tell you what you can and cannot do. It's also a good idea to have your attorney review the final draft of your proposed articles of association before presenting them to the membership for a vote. As the saying goes, an ounce of prevention is worth a pound of cure.

Sample forms for articles of association and bylaws may be found in Howard Oleck's *Nonprofit Corporations, Organizations and Associations*, Prentice-Hall, Inc., Englewood Cliffs NJ, 1974. Remember, the forms are for guidance. Don't rely on them too heavily.

In drafting your articles and bylaws, there are some real life problems to keep in mind. For example, on the theory that directors are more apt to handle club chores, it may seem like a good idea to have a very large board of directors. But consider the problems of getting a quorum at board meetings. You're better off with a small (five-to-seven person) board and an active committee structure. Speaking of quorum requirements, consider a low one, perhaps 25 or 33 percent. Club members are known to avoid business meetings like the plague. A crucial bylaw amendment may wither on the vine while waiting for a quorum at a business meeting.

In lieu of low quorum requirements, you may wish to provide for proxy voting on all club business. However, proxy voting is relatively expensive; proxies must be printed and mailed to all club members. If your club will have a newsletter, the additional cost can be avoided by printing the proxy.

While it is strongly recommended that the founders of an unincorporated association take the time to prepare written articles of association and bylaws, the overriding reason for organizing your club as an unincorporated association rather than as a

nonprofit corporation is because of the relative informality of organization and operation.

The greatest disadvantage in going the unincorporated association route is the possibility of the tort liability of one member being imputable to all other members of the association. In other words, if a member or guest develops ptomaine poisoning from coffee served at a club meeting, all club members may be liable for damages. In general, the same principle is applicable to contractual obligations of the association. However, some states provide that by merely joining an association there is no presumption or inference of consent to the assumption of personal liability on behalf of the member for the contractual debts of the association. Nevertheless, personal liability of members is the overwhelming disadvantage in adopting the unincorporated association form for your club. Because of the potential liability of members for other members' actions, it is important that the club obtain some liability insurance.

Nonprofit Corporations

If you wish your club to take on a more formal character, it can be organized as a nonprofit corporation. A nonprofit corporation is one that is not intended to, and does not, produce monetary gain for its members. However, the fact that financial gain does accrue to an organization from its operation does not make it a profit or business organization if such gain is devoted to the maintenance or improvement of the club (i.e., buying a club microcomputer). The bottom line is that no profit can be paid to club members as ordinary corporations pay their shareholders dividends.

Contents of the articles of incorporation of a nonprofit corporation are simi-

continued on page 18



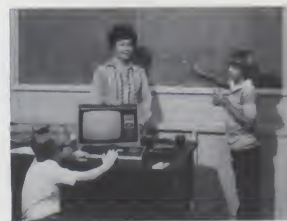
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NEW PRODUCTS

OSI's Challenger II

Ohio Scientific announces a new addition to its Challenger line of products, the Challenger II.

Challenger II is a complete computer equipped with the new 500 CPU board and an 8K BASIC in ROM option that advances a substantially improved cost/performance ratio.

Available in two video-based models, the IIV and IIP, Challenger II contains a 256K byte memory management and can be operated at 1 or 2 MHz.

Ohio Scientific also offers a full software library, mainframe expandability and an accessory line for Challenger II flexibility.

Additional Challenger II features include 4K RAM on CPU, serial port on CPU and software compatibility with the original Challenger.

text editor; and FORT80, FORTRAN IV for the 8080 microcomputer. The kit will operate with any Altair bus system with 20K of RAM.

The interface module is an Altair bus pluggable, fully socketed PC board with an on-board bootstrap and diagnostic PROM. The interface can control two minifloppy drives. Power is supplied from the Altair bus, with power regulators on the board for the first drive. Power regulation hardware is supplied with the second drive, when ordered. The interface module is a disk driver and parallel I/O module in one. It features on on-board crystal controlled timer, providing compatibility with any 8080 series processor, independent of cycle time.

Also included are vectored interrupts, selectable to any of seven possible



OSI Challenger II.

FORTAN IV Minifloppy Kit

The Realistic Controls Z25 FORTAN IV Minifloppy Kit includes a Shugart SA400 Minifloppy disk drive, cables and cabinet; an interface module kit; a disk operating system with file management; a

vectors with software sensing of interrupt enable/disable status. The module also includes an 8-bit parallel input port with input strobe and an 8-bit parallel latching output port with output strobe.

Complete documentation, a 90-day warranty, factory support, and a two-year software and documentation update service are



FORTAN IV Minifloppy Kit.

provided. The FORTAN IV Minifloppy kit is priced at \$1095. A completely assembled and tested unit is \$1220. A second minifloppy drive, regulator and cable kit sells for \$449 (\$495 assembled and tested). Additional formatted diskettes are \$5. From Realistic Controls Corp., 3530 Warrensville Center Rd., Cleveland OH 44122.

Vector I Computer Kit

Vector Graphic Inc. announces a rack-mount version of its popular Vector 1 computer. At \$225, the kit includes card cage, 18-slot motherboard assembled and tested with 18 connectors, card guides and locking buttons for 18 cards. The motherboard is fully shielded to reduce noise on the bus.

A heavy-duty modular power supply is also available. The 18 A 8 V, 2.5 A ± 16 V custom supply provides sufficient power for

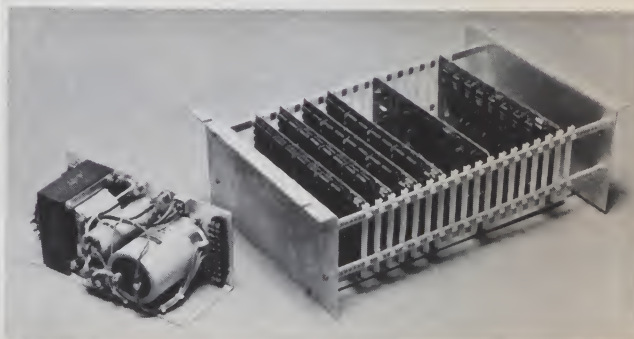
full 18 boards. The transformer has primary taps for 110 V, 120 V, and 130 V, all Class B insulation and includes mounting bracket, fuse and all hardware for \$90. All components are the same high quality used in the Vector 1 computer. See your local dealer or write for further information.

Vector Graphic Inc., 790 Hampshire Road A-B, Westlake Village CA 91361.

Heath Markets 12" CRT Terminal

Heath Company, world's largest manufacturer of kit-form electronic products, has introduced a video terminal for the computer hobbyist and small business user. The H9 is an alphanumeric video terminal designed to accompany Heath's H8 and H11 digital computers, but it will work with any digital computer.

The H9 utilizes a full 67-key ASCII keyboard with a 12-line, 80-character format on a 12-inch CRT.



Vector Graphic Rack-Mount Computer.



Heathkit H9 CRT Terminal.

Other features include a format option of four 12-line, 20-character wide columns, cursor control, a batch transmit feature and a plot mode. Standard serial interfaces include EIA, 20 mA loop and TTL input/output. The baud rate is selectable, from 110 to 9600.

The kit-form, mail-order price of the H9 is \$530. For more information about the H9 CRT Terminal and Heath's complete line of computer products, write Heath Company, Dept. 350-26, Benton Harbor MI 49022, for the Computer Information Package.

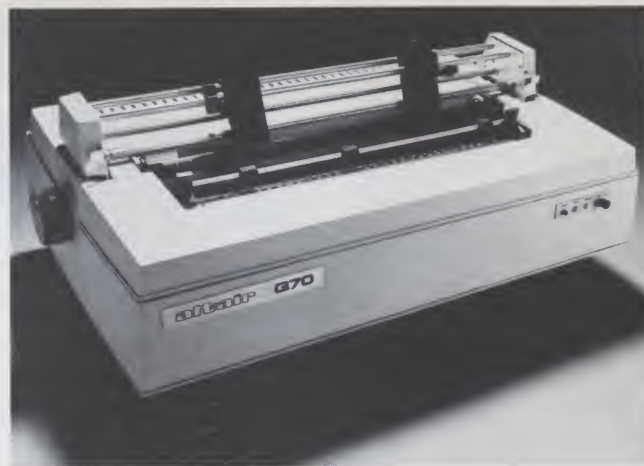
SWTPC Dual Minifloppy Kit

The \$995 MF-68 Minifloppy Disk System by Southwest Technical Products Corp. is designed for

use with the SWTPC 6800 Computer System. It includes all hardware and software needed to provide a complete high-quality dual-disk operating system. The system can be expanded to its four-drive limit with an \$850 MF-6X expansion kit.

The extensive software provided with the MF-68 includes both disk BASIC and a floppy disk operating system (FDOS). Operating system commands make disk operation, including copying all or any part of one diskette onto another, simple and easy. Commands include CREATE, SAVE, RUN, LOAD, PURGE (delete), PACK, CATALOG, RENAME, INITIALIZE and PATCH.

The MF-68 is offered in kit form only. It includes controller, chassis, cover, power supply, interconnecting cables, assembly instructions, two assembled Shugart minifloppy drives, and a diskette with the



Altair Q70 Printer.



Altair C700 Printer.

FDOS operating system and disk BASIC.

The MF-6X expansion kit includes power supply, chassis, cover, and two assembled minifloppy drives.

Prices of \$995 for the MF-68 and \$850 for the MF-6X include prepaid postage. Write Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio TX 78216.

The printhead is a 5 x 7 dot matrix that prints the 64 character subset of the ASCII font.

The Altair Q70 is an upper and lower case, electric typewriter-quality printer specially designed and modified to interface with the Altair 8800 series. It prints 96 upper and lower case characters and symbols at 45 characters per second. The Q70 is ideal for business systems, word processing systems or any other application requiring high-quality printout for letters, labels, documents, etc. Each printer operates in a unique highly efficient manner. The C700 calculates the most rapid way to print each line so that unnecessary carriage returns are eliminated.

The Q70 operates with a "daisy wheel" system to rapidly print upper and lower case characters. The

New Altair Printers

Mits introduces two new peripheral products — the C700 high-speed printer and the Q70 printer — to interface with the Altair 8800 series microcomputers.

The Altair C700 is a high-speed serial character printer which prints up to 60 characters per second.



SWTPC Dual Minifloppy System.

wheel spins for character location, and a hammer then forces the wheel against the ribbon, paper and platen.

Both models provide other features for easy operation with minimal maintenance. Each printer is furnished with form tractors to accommodate forms up to 15 inches in width. An electronic Top of Form in the Q70 provides rapid positioning of each sheet. A manual Top of Form switch is also included. With the Q70, ribbon and/or wheel replacement is not an exasperating, messy task. The print wheel is easy to replace, and the ribbon is conveniently enclosed in a cartridge.

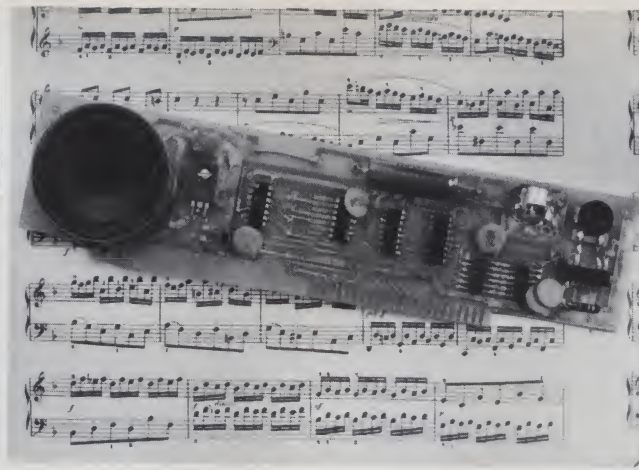
When set to print less than 132 centered character lines, the C700 has increased throughput, since the printhead returns to the right or left margin. This special feature results in minimal wear because parts motion is reduced to a minimum. A circuit that allows power to be decreased when the printer is inactive further reduces wear.

Both printers are easily integrated into any Altair 8800 computer system. Each comes with its own special interface card that plugs into the Altair bus. Ribbon cables and connectors complete the interface by connecting the printer to the computer via the interface board. Write Mits, Inc., 2450 Alamo S.E., Albuquerque NM 87106.

Altair Bus Compatible Music Board

Newtech Computer Systems' low-cost Model 6 Music Board enables anyone with an Altair bus computer to produce music and sound effects. Applications include generating melodies, rhythms, sound effects, Morse code, touch-tone synthesis and much more.

The Newtech Model 6 Altair bus compatible Music Board comes fully assembled and tested. Its features



Newtech's Model 6 Music Board

include selectable output port address decoding, a latched 6-bit digital-to-analog converter, audio amplifier, speaker, volume control and RCA phono jack for convenient connection to your home audio system. It employs a glass epoxy printed circuit board with plated-through holes, gold-plated fingers and top quality components.

A complete users manual, supplied with the Model 6 Music Board, includes a BASIC language program for writing musical scores and an 8080 Assembly Language routine for playing them.

Price of the Model 6 Music Board is \$59.95 through computer stores. Delivery is currently from stock.

For information, contact your local computer store, or write to: Newtech Computer Systems, Inc., 131 Joralemon Street, Brooklyn NY 11201. Newtech's telephone number is (212) 625-6220.

Terminal Strips For PC Boards

The TS series of terminal strips provides solderless termination of wire leads via positive screw-activated clamping action. Strips are available with 4, 8 or 12 positions and accommodate wire sizes 14-30 AWG (1, 8-0, 25mm). Pins are silver-

plated brass, .040-inch (1mm) diameter, on .200 inch (5mm) centers. Features include unbreakable polyamid bodies and consecutively numbered terminals. Rated 10 Amp at 300 V. In stock for immediate delivery from OK Machine and Tool Corporation, 3455 Conner Street, Bronx NY 10475.

Dynamic Debugging System

The Dynamic Debugging System (DDS) is a powerful debugging facility for 8080 assembly language programs. DDS operates in a variety of ways which you select to meet your needs. DDS can run your program one instruction at a time, automatically maintaining on the screen a display of all registers, the following instructions and portions of memory. Like conventional debugging programs DDS can also operate in a breakpoint mode in which the

program runs at full speed until it reaches one of several selected instructions. Although a breakpoint capability is necessary, if it is the only facility available the debugger will be tedious to use, since you will have to breakpoint around almost all branch instructions. The automatic program monitoring facilities provide a powerful alternative to the drudgery of using breakpoints. Rather than running the program yourself with breakpoints, DDS can run it for you, until a condition you have specified occurs or DDS detects an error by itself. These combinations of features make DDS the most powerful debugger available today on any microcomputer.

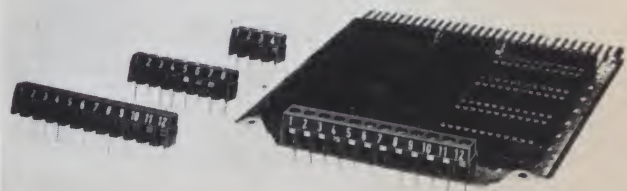
The cost is \$30 on paper tape or cassette and \$35 on diskette. Contact The Computer Mart of New Jersey, 501 Route 27, Iselin NJ 08830.

Prototype Cards

Two prototyping boards for either wire-wrap or soldertail and wiring pencil are now available from Personal Computing Company, Dallas TX. These boards are either I/O size or memory size. They are compatible with the SWTPC bus structure and motherboard as they use the molex connectors at the bus interface. In addition other connectors are provided to allow off board and I/O functions.

The cards are arranged in rows of holes with the holes on 0.1-inch centers and the

continued on page 19



OK Machine's Terminal Strips.

BOOKS BOOKS BOOKS

Chess and Computers

David Levy

Computer Science Press
4566 Poe Avenue
Woodland Hills CA 91364
\$11.95

Need a good solid introduction to developing a chess program? This is it. From the basics of digitizing the chess board and moves of the pieces to aid in weighting strategies for the optimum move — it's all here and highly readable.

How many moves ahead should a program realistically look? How important is control of the center of the board? International chess master David Levy provides perspective on these questions and gives us the two most important criteria for developing a winning program — material and mobility. As tournament director of the annual U.S. Computer Chess Championships he should know. The design of a good program is developed by following the history of computer chess from its beginning in 1949. There are plenty of ideas here for your program. (I cheated — I bought an excellent 8080 program from Micro-ware in Toronto.)

How good is a computer at chess? Certainly not good enough to beat Mr. Levy, who has bet over \$5000 that no computer program can beat him by 1978. This is even more remarkable because he made the original bet almost ten years ago. Currently, the best chess program is at Northwestern University, winner of several U.S. championships. This program and others are described with documentation of some of

the games played. Some of the computer's moves are quite surprising.

Not so surprising is that the world's best chess players have the best program. The Russians won the first international championship in 1974 and are scheduled to defend in Toronto in October. Using almost no look-ahead for possible moves, the Russian KAISSA program is unique.

Although the computer has yet to become the best chess player, increasing use is being made of its capabilities — especially in end games with few pieces left. In games where grand masters had agreed to draw, the computer has found winning lines.

Sadly, *Chess and Computers* ends with a stop press item on a computer that was unbeatable. The hoax had P-KR4 as the start of an unlosable game. Rumor spread that Bobby Fischer would play it. For \$25 million — of course.

F. Gerlach

Ft. Lauderdale FL 33310

Homeowner's Guide to Solar Heating and Cooling

William M. Foster
TAB Books, #609

With the threat of an increase in the cost of energy hanging over our heads, a guide to the use of solar energy, such as Mr. Foster's book, seems to provide an opportunity for productive reading. But in a computer magazine? Certainly! The true computer hobbyist has talents (and usually knowledge) covering a far broader

field than computers. As much as the computer itself, the possibilities for utilizing it cause the digitally infected blood pressure to rise; and what better area to consider than that of our own comfort at an economical price.

Articles on home energy management systems are beginning to appear. One article on microcomputer controlled solar energy systems was printed in *Kilobaud* recently. The obvious next step is accumulation, control and distribution of solar energy, all efficiently managed by a micro. For the hobbyist interested in such a system, *Homeowner's Guide to Solar Heating and Cooling* is a good tutorial and reference.

Foster provides the background information in his well-organized book — information necessary for the planning of a solar heating system — and accompanies that information with interesting bits of history.

This book is by no means a pie-in-the-sky postulation of what could be. It is a practical guide for the conservation minded do-it-yourselfer which considers such things as the economics of a solar energy system, the effect of geographic location and the size system needed for a particular application. Many types of collectors, some of which can be built easily by a person handy with tools, are pictured and described. Also pictured are several existing installations.

All but one of the major portions of a practical residential solar energy system are discussed at a level of detail necessary to support a productive effort. The one weak point is the portion of the book that deals with cooling. This must be tolerated, though, because cooling has yet to receive as much attention as heating from those endeavoring to harness solar energy.

Two chapters deal with two specific applications: solar water heaters and heating a swimming pool

with solar energy. The degree of detail in these chapters is good. Everything from load calculations to economics is discussed and explained. The illustrations are accompanied by enough tutorial to enable the reader to make the appropriate calculations for his own residence.

For those wishing more detail, a bibliography is provided. For those planning an installation, a list of manufacturers is given. Though far from complete, it will provide the beginner with a good start.

Those already experienced in the art and science of solar energy conversion and storage will find the *Homeowner's Guide to Solar Heating and Cooling* old hat. However, from the systems point of view, the book is more than adequate as a guide for the novice.

Art Childs
Glendale CA

The Great International Math On Keys Book

Texas Instruments Inc.
\$4.95

It would really be a mistake (I made it!) to order this book if your calculator does not have built-in "Hierarchy." (TI's AOS). This means that chain calculations are internally held back and then performed only according to the old school days rhyme, "My Dear Aunt Sally": Multiplication and Division first, then Addition and Subtraction, from left to right in each case. Apart from the extra "equals" this method makes necessary, it has considerable advantages. However, no concession to any other calculator format has been made in this book, and what disturbs me most is that TI has conveniently omitted this information from their promotional blurbs. Attempting to modify the few worthwhile algorithms (there's a passable chapter titled "Turning

continued on page 18

LETTERS

Glimpses of the Future from NCC

I am sure you will have articles on the NCC '77 held in Dallas. I hope you will compliment the convention for its efficiency in handling a crowd of 36,000 people. Personal computing was a small part of the convention, but the panel sessions deserve some comment. I would like to comment here on the "prophets" who participated in the panels. The two most notable were Adam Osborne of Osborne Associates and Dennis Allison, who is a new editor on IEEE's *Computer* and is a well-known consultant. Let me begin with a quote from Adam Osborne about the purveyors of personal computing:

(They are) making new markets which have never existed before. They have not been serving any prior customer base. For that reason using any kind of past precedence or past experience as the basis for what you will do in the future has no credibility or viability, and will not work. Because, everything that has been happening and will be happening is only happening because the product has made its market. This has been the key to what it has taken to get into the market in the first place... You are going to make the market; you are not going to fill one.

I believe this to be a point not previously understood by many. This statement and some additional quotes by Dennis Allison provide for some interesting extrapolation. Allison: "Compilers, Assemblers and Interpreters are the tools, not what we are trying to accomplish." "Most people

don't want to program in Assembler... surely not hexadecimal. For that matter I'm not sure they would be happy with BASIC, FORTRAN, APL, ALGOL or any of the other languages." "We ought to accept our losses and go on from here (speaking of BASIC)."

One of the first conclusions is that standards don't count for much yet. The S-100 bus is not two years old, but there has been time to establish several devices that use this bus. Furthermore there are reasons why the bus is unsatisfactory. There is every reason to believe that a new and better product could storm the market as easily. In software the situation is still clearer. There are ANSI standards for COBOL and FORTRAN, but every machine offers enhancements. The result is that no one writes programs in ANSI standard anyway. The standards are always too much compromise.

A second message is that hobby computing is not, and will not be, personal computing. The classical hobbyist will always have a toe in the market, but the majority will soon be end users — people who really don't want to know very much; I don't believe most people who buy RC planes or shortwave receivers know very much about radio. This is important, because it means Commodore is going to sell a million PETs and Heathkit is going to get rich. It also means that software piracy is not really a problem; Gary Kildall of Digital Research (another prophet) is right about selling software for \$50 or less and selling many copies. The systems developers, like Yourdon and his "C" for the 8080, will be able to sell their \$5000-10,000 product

to the manufacturers and not worry about violations of their licenses.

There is a golden opportunity to be a maverick and pull it off. For the manufacturers that means a micro designed to higher order language, and not some compromise to process control or the architecture that can be packed on a chip. For the software developer it means you don't have to suffer with BASIC "because that's what everyone has." Passive acceptance (or worse — active support) of standards is a Trojan horse and will deprive us of many golden opportunities.

Personal computing is underestimated by everyone. It is not just one market; it is more diverse than we know, or imagine. There's meat with salt and pepper for everyone, and the best morsels haven't been picked up yet. Pertec and Mits were once garage operations; *Kilobaud* jumped in late, and there are numerous other examples of organizations that bucked time-honored marketing knowledge. It seems to be true very often in our field that newest is best. I hope sincerely that *Kilobaud* can continue to be newest.

Robert W. Ferguson
Wake Village TX 75501

"Wish I Had Said That"

As usual I couldn't wait until the 10th of this month; that's when *Kilobaud* appears on the newsstand at Bargain Electronics. I rushed, ran and tripped into Bargain for the August issue, and was not the least bit disappointed in the contents. I was particularly interested in George Young's article, "Sooo, You Want to be an Author." It was one of those articles about which I wanted to say, "Gee, I wish I had said that." George stresses some very important aspects of magazine writing. I can testify to the fact that if

your manuscripts are not presented in a clear and concise manner they may not be accepted or may require additional work. I have had one article rejected and two accepted. The second one required rewrite of sections on my part and extensive editing by John — which I appreciated — but with a little attention on my part, these would not have been necessary. John has given me many valuable pointers, which I am willing to share with anyone in the L.A. area who plans to write an article.

Incidentally, I was very pleased with the response I got from my first article and apologize for not being able to answer all the letters I received. I have put together a little booklet of CT 1024 Mods which anyone can have for the copying charge \$2. If I could copy it for free I would give it away. For those wanting business programs I have many in the works that I hope will appear in the pages of *Kilobaud*. I hope by the first of the year to have a book out geared to small business applications.

Keep up the quality of the magazine and I'll keep getting it from the newsstand until my subscription to *Byte* runs out in five more months. Maybe I can convince my wife that a 3-year subscription is needed now. By the way, since I am a member of your future millionaires club I am only \$999,787 away.

Carl Denver Warren II
Torrance CA 90505

The Next Generation

I enjoyed scanning your June issue because much of it is beyond my pre-hobbyist level. It was interesting to note that the publication is targeted primarily at hobbyists, but seemed concerned with increasing the overall interest in small computer usage.

I am clearly a novice, and not one interested in either assembling kits, or writing

more programs than necessary, but I would like the opportunity to answer the question (for myself) on the kind of articles wanted for reprinting. I am a pragmatic, applications-oriented person who would like to know:

1. Has anyone used an IBM MT/ST Model 4 as an I/O device in a small system? These are rapidly being replaced in their original role of word processor, and may be available rather inexpensively. With the dual tape model it could store a lot of names and addresses for mass mailing, if adaptable.

2. Has anyone written a program that plots the "puts" and "calls" of the listed options against the decreasing time value of the option(s) and the fluctuations of the underlying stock? The variations possible in these positions make a computer useful in gauging returns or planning hedges.

3. Has a program been written to evaluate the returns of rental properties so that individual variables can be changed, and the impact on the investment immediately seen?

As you can see, this pre-hobbyist isn't interested in becoming a hobbyist, at least not in the sense of putting together hardware or writing software. I admire those who can and do, but my primary purpose would be in using the personal computer as a versatile tool. If you can recommend a publication more suited to my needs it will be appreciated.

Paul N. Stronger

The publication you're asking about isn't here just yet, Paul. Although there are a lot of people with your interests, there aren't enough to warrant another magazine. But there will be, there will be. — John.

PET User Group

A user group has been formed for people interested in the Commodore PET 2001, a compact computer with integrated key-

board, CRT with character and graphics capability, cassette drive, 14K ROM Operating System, including full 8K BASIC, and 4K RAM user space. The PET will provide exceptional computing value with a complete price of \$595.

The purpose of the group will be to share and exchange applications, programs and hardware expansion techniques, and to provide general user feedback. The first year membership is \$5 and will include the User Notes publication.

Gene Beals
PET User Group
PO Box 371
Montgomery PA 18936

Machine Code Version of Hexdec, Please

F.B. on the Hexdec program, page 105, issue 8. Kindly get this done for *Apple 1* and *8080*. This is something we're all interested in!

We love you.

Philip H. Morrison, M.D.
Bristol TN 37620
Und vot is F.B.? — John

Change the ANS Flowchart Standard?

The ACM's SIGDOC group has started a review of the flowchart standard (ANS X3.5-1970). The committee seeks written comments and suggestions for the improvement, modification or change of the current standard. If no change is appropriate at this time, please say so.

All types and levels of suggestions and comments are welcome. All concerned persons in the computer field are eligible. You have knowledge and experience — let them count by sending your written comments and suggestions to Ned Champin, Flowchart Committee Chairman, InfoSci Inc., Box 7117, Menlo Park CA 94025.

Ned Chapin, PhD
Menlo Park CA 94025

332,193 Bits Per Second!

Your articles on digital audio were read with great interest. Although the author refrained from being technical he should have at least included the famous Shannon-Hartley Law, which states:

$$C = W \log_2 \left(1 + \frac{S}{N} \right)$$

Where:

C is the channel capacity in bits per second

W is the channel bandwidth in Hertz

S is the signal to noise ratio.
 N

Assuming a bandwidth of 20,000 Hz and a signal-to-noise ratio of 50 dB (100,000 to 1) the channel capacity of a hi-fi system is 332,193 bits per second.

Rob Cave
Irving TX 75061

PASCAL to the Rescue!

Glen Charnock's article, "Structured BASIC is Better!" (No. 5, p. 104), is an ingenious attempt to make a silk purse out of a sow's ear, but it raises the question: "Better than what?" Why go to such lengths to write structured programs in a language that fights such attempts every step of the way, when infinitely superior results can be had by simply using a fully structured language such as PASCAL to begin with? Consider how Mr. Charnock's Program C might be written in PASCAL:

```
repeat getinput; process; print-
output until endofjob.
```

Surely Mr. Charnock would have to admit that this single line of PASCAL expresses the algorithm involved much more clearly and concisely than his 17 lines of "structured" BASIC. Now that PASCAL is becoming available for the 6800, the 8080, the Z-80 and all the rest, I can see no

excuse for not making it the standard hobby computer language and junking BASIC altogether. Attempts at patching BASIC merely lull the programmer into an unwarranted complacency by obscuring the advantages that languages such as PASCAL offer.

David A. Mundie
Charlottesville VA 22903
Being realistic, David, there's no way we're going to be "junking BASIC altogether" in the foreseeable future. Undoubtedly, PASCAL will make an impact in the years to come, and a lot of us are anxious to get it up and running on our 6800s and 8080s. — John.

F8 Owner's, Unite!

Would you please publish a note in *Kilobaud* and *73* that we would like to contact individual users or groups that are interested in the Fairchild F8 computer.

We are starting a users group in the Hartford area, and as of this writing we have three units operating.

There must be others that have built the F8 and are writing programs for it. It's a shame that there has not been more information about the F8.

We hope we can generate more information flow about the F8 as we believe it is a rather inexpensive way to get started in computing.

Gerald W. Hemphill
132 Scott Swamp Road
Farmington CT 06032

6502 Forum?

I almost didn't believe my eyes when I saw the KIM FORUM in the July issue of your magazine. That is one feature of your magazine that is going to keep me reading it.

I think the KIM FORUM is going to be a great equalizer and will help make the 6502 (or 65XX) one of the big three; or is that four? I myself have ordered an E.C.D. Micromind II. At

first I was a little unhappy that they used the 6502 (actually 6512A), but I couldn't find a better system for the price so I bought it anyway. Now that I see that *Kilobaud* is going to pay some attention to this chip I feel a lot better about my decision.

As for the name of the column - I'm glad you mentioned that there may be a name change "some-time in the future." Please don't delay the name change for too long. Since there are "over 6000" KIMs in the field, the original name is fine for seven or eight months. However, as I see it there is going to be a flood (?) of 6502 machines in the field by then. This is because the 6502 is being marketed primarily in assembled and complete systems for what appears to be low cost. The Apple II and the Micromind I are good examples. There are a lot more people wanting to use computers than there are who want to build them or even just interface things to them.

I find it rather curious that neither the Apple nor the Micromind is advertised in your July issue. Anyway, keep that 6502-oriented forum coming, and please don't skimp on space for it.

K. Matthews
Langley, BC V3A 5V4

Attention
Brooklynites!

I'm really not writing this letter directly to you, but rather I'm appealing to my fellow hobbyists. I have noticed many letters from Brooklynites. This doesn't surprise me since Brooklyn is the fourth largest city in the United States in population. To my dismay, however, I am not aware of any club in Brooklyn. I know that we have a computer club based in New York City, but none representing Brooklyn itself.

I'm sure there are many hobbyists in Brooklyn, and I think we should be represented. I think writing this letter is the first step. So to

all you fellow Brooklynite hobbyists, drop me a line and let's get together.

Note to the editor: Perhaps you can give me some pointers on how to start a club.

John P. Wasack
1438 83rd Street
Brooklyn NY 11228
July 12, 1977
Tel: (212) 331-7071

It looks to me like you're doing a pretty good job without any pointers, John. You probably should get a meeting place lined up to handle the response. (Let's hope it's that big, anyway.) - John.

Forgive Us Our Trespasses

Someday Sears and Tandy will sell microcomputers - millions of microcomputers. But four things will change first - four glitches in the "hobby" market.

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:
:
: THIS PROG. IS COMPLETELY DEBUGGED. IT REQUIRES THE INTER *
: FACING OF TWO DIGITAL OUTPUT DEVICES HAND 1 AND HAND 2.
: IT REQUIRES THE SHUT DOWN OF THE TWO INPUT DEVICES EYE 1
: AND EYE 2. DISABLE ALL INTERRUPTS DURING RUN. OUTPUT MAY
: BE DELAYED.
: OF VER.1.5"
: "J. CHRIST"
:
: OUR FATHER
:
: WHO ART
: RESERVED SPACE
: ADD NAM + HLOW
: GOTO END
: OUTPUT
: MOV HVN TO ERH
: GET ONE BYTE
: DECREMENT SIN COUNTER
: CHECKSUM
: WIPE TEMPT REGISTER
: WIPE EVIL REGISTER
: END
:
WART
HVN
HLOBNAM
KINGCOM
WILDO
ERH ← HVN
BRED GIV
SINFORGIV
ASWEFORGIV
TEMPTNOT
DLVRVL
AMEN

```

First, there will be polite salesmen. People who notice when you come in the store. People who don't think you're an idiot if you ask a simple question. People who know that a 69¢ part needs as much attention as a \$500 stereo.

Second, they will sell a function, not a "geewiz." I am not going to spend \$2000 to play Wumpus, complete with lights and buzzers, and neither is anybody else. But I may spend \$500 to control my heat

and lights. Or I may spend a grand to tutor my kid in math or language. And I may find a few thousand to lower my billing and inventory costs.

Third, they will use a standard 44-pin edge connector. Does the 100-pin bus add to memory capability? Input and output capability? No. All it adds is cost and 66 more things to go wrong. The Z80 (for example) 40-pin bus is elegant and simple. Like any good design it does more with less. The 100-pin bus is a mess of duplication and confusion, a step backwards. With millions of units they will be able to set their own standards.

Fourth, they will chain the engineers and programmers to a wall in the back room. Though these two are geniuses and essential, they are basically illiterate and should not be allowed in polite society. What improvement is MOV over move? What is a PDBIN? Indeed, we need

May I share with you the programmer's prayer?

Maybe the OF can understand that, but the rest of us are puzzled.

Charles Johnsen, III
Batavia IL 60510

Z80 BASIC Patches

Here are the patches that I was using to run Altair 8K BASIC (VSN 3.2) on a Cromemco ZPU.

These patches may be located anywhere the user can find space for them. Mine are located in a monitor EPROM. They correct the parity flag. For other versions of BASIC the locations where parity is tested after an add or subtract must be found and similar routines written.

I am now running a North Star disk system at 4 MHz with one wait state inserted by the ZPU hardware. To do this I must first transfer the contents of the bootstrap ROM to an Altair 1K

jargon and abbreviations. But we also need consideration. Learning to program is hard enough without having to learn it in Chinese - abbreviated Chinese at that. *Kilobaud* gets an A+ for English class.

I'll bet that Sears will use only one abbreviation: the trademark symbol.

Programmers are like priests - they are not sure they like this lay movement and insist on talking Latin. I know a little bit about that; I am a Lutheran minister.

static (which is a slow memory), modify all locations that contain 351 to the new page number I have transferred it to. Then jump to this new location. The following locations in DOS must be also changed to the new page location.

This system runs at a cycle time of 1.25 microseconds. It runs benchmark 7 in 47 seconds (*KB* June). I found the North Star system to be very good. It does not

continued on page 19

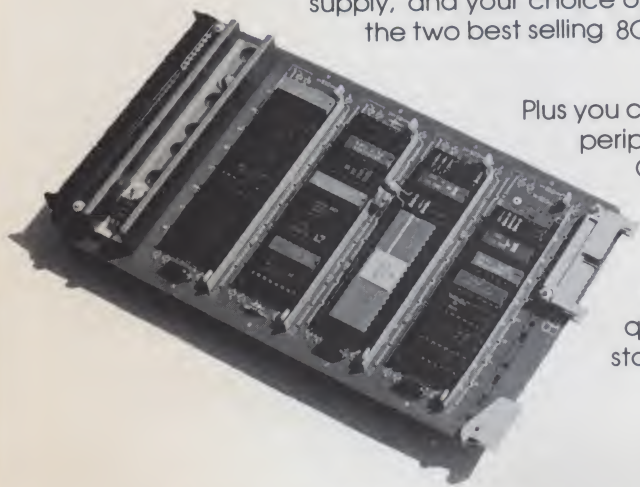
WAVE MATE



(shown with Jupiter disk)

LOOKING BETTER ALL THE TIME

But we offer you more than just a beautiful new cabinet. The Wave Mate Jupiter IIA and Jupiter IIIA systems come to you fully assembled and tested, with backplane, plug-in ferro-resonant power supply, and your choice of either 6800 or Z80 CPU modules. All for less than the price of the two best selling 8080 systems!



Plus you can choose from the fastest growing selection of memories and peripherals available from any manufacturer.

Our 2KB EPROM/4KB RAM/Serial interface module can start you on your way to high-quality, full capability, low cost personal computing. As your needs for computing power grow, add our video modules, our audio cassette interface, or even a high-speed matrix printer or floppy disk - all built with the same quality and dependability the Wave Mate name has come to stand for.

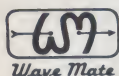
All Wave Mate products meet the highest quality industrial standards, with rugged construction unmatched by anyone. If you are serious about personal computing, call **Wave Mate**.

Send information on: ☐ Jupiter IIA
☐ Jupiter IIIA

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____



WAVE MATE 1015 West 190th Street, Gardena, California 90248 Telephone (213) 329-8941
Dept. 25

W5

AROUND THE INDUSTRY

Mini Micro Mart Speaks Out

This is a delayed response to a letter to *Kilobaud* from one of our unhappy customers with regard to a 6800 system. I am also tired of hearing how bad Mini Micro Mart is! We have a few happy customers and many, many unhappy ones. There is no one to blame but myself — we offered too many products, most of which no one else would even bother to produce — and tried to supply them at anywhere from 10 to 40% lower than the competition.

When we first started we assumed that the hobbyist computer marketplace was similar to that of the electronics hobbyists' I was familiar with; a tinkerer with a fair degree of knowledge could speed up production of his home brew project with a usable PC board and some quality components.

We totally misjudged the marketplace; the personal computing field is expecting and getting professional-looking products extremely well designed at fantastically low prices. I spent ten years in the electronics industry and know of many commercial electronic instrument producers who do not expect the same standard of quality in their PC boards as the computer hobbyist.

Back to Tim Ahrens' letter with regard to our 6800 system; I am not totally in disagreement with his comments. Our RM 6800 board with some documentation and a few mods would have been the best of the 6800 systems on the market. For a great variety of reasons too numerous and involved to get into in

this letter, we have discontinued our 6800 system. I still feel that it was the best value on the market and there are some very happy owners. You have little reason to hear from the happy ones; it is the unhappy ones who have something to write about.

In spite of all the bad things you hear about us, most of the business we enjoy is repeat business from universities, engineers, and commercial users. And while I'm rambling on about the personal computing industry, perhaps our major error was in the use of kits; I wish there was some word to describe what we and some others have to offer other than the word "kit"; as only a few of our offerings resemble kits as some people have come to know them. If current rumors are true, it certainly is noteworthy to observe that Heath — the granddaddy of the electronics industry will be selling assembled minicomputer systems, and not kits. If this is true, perhaps they have learned something from the mistakes and misfortunes of Mits, Imsai, SWTP, Mini Micro Mart and others.

Since *Kilobaud* and other consumer hobbyist magazines seem so intense in their desire to see that the consumer gets his money's worth, I would think it would be your duty to take a good hard look at our RM Z-80 system. Our assembled and tested system board costs about \$300. If there is anything that offers more in versatility, in features, or that is as powerful for that kind of money, I'd like to know what it is.

Keep up the good work.

Maury Goldberg
Mini Micro Mart

Good Words About Mini Micro Mart

I recently ordered two 2708 PROM boards (C80-2708-2) from Mini Micro Mart. They arrived surprisingly quickly (three weeks) especially considering payment was by personal check. Each kit consisted of a board, bag of parts, a parts list, two sheets of pictorial and schematic, and one sheet of brief but complete application notes.

There were no assembly instructions as such, but the whole kit was enclosed in a printed jacket bearing, among other things, a comprehensive statement of warranty, the usual components information and construction hints, and a sales policy statement which clearly proclaims that this is a "bare bones kit" intended to provide high quality at a low cost for experimenters, engineers, and advanced hobbyists. It further states that the buyer who feels that such a kit is beyond his capabilities should return it for a refund. They also offer a repair service. What could be more fair, especially since the price is about one half that of the nearest competitor.

One capacitor was missing from each kit, but at 38 cents each from a local supplier, who cares? The boards were of excellent quality (plated through holes, gold fingers, etc.) without solder masks, so required care, but assembly was very easy. These boards are very flexible, allowing use of 2704, 2708, 2716 or 8316 PROMs, for a possible total of 12K. Each PROM may be individually addressed to any 1K of the memory map, and the application notes are clear on how this is done, including examples.

The boards worked perfectly on the first try, and have been solid ever since. Which brings me to the letter and editors comments in the July *Kilobaud*. I too have been hearing rumors about MMM for some time, but have not been able to pin down any real sub-

stance. Even Tim Ahrens' letter allows that the problems were more misunderstanding than design defect. This has been my only contact with MMM so far, and I am left with a real question. Are these the only good boards that MMM has made? It is more likely that many of the problems may have come from builders who may have gotten in over their heads. MMM appears to be a small scale operation, and sparse documentation is an essential part of the low price.

Just for purposes of comparison, I would like to recount some of our experiences with Imsai products. Several of us working together ordered Imsai 8080s, two as kits and one factory built. The kits arrived in about six weeks. The front panel boards required X-acto knife work, and home brew additions to get the programmed output LEDs to work right side up as they should. PC layout might well have been done better in some areas, particularly the power lines on the motherboard, but all in all the systems were up and running in a couple of weeks. No such luck with the factory built unit. It took six months to arrive, and it did not work! Since the factory built unit had ICs soldered into the PC board (ugh), we returned it without tinkering and it has now finally arrived in working condition.

We also purchased two Imsai PIC-8 priority interrupt boards, one built and one kit. The kit was easy to assemble, but the users guide ranks somewhere between fragmented and pure chaos. At least a sample test program to give the builder some feel for how the board should be used would have been of tremendous value. Better than MMM's documentation? Not really. In the details that really count, it may not be as good. And remember that Imsai boards command a premium price. And what about the factory built PIC-8? Well, it's defective. Clock rates are wrong. Soldered-in ICs too. We have yet to resolve that

one.

We recently got one of Imsai's new MIO boards. Top quality components and very fine board. Assembly instructions were tedious with much time wasted looking all over the board to find resistor locations in the order in which they were presented. A well labeled print would have been ten times faster. An immediate disappointment was the inability to change data rates under program control (like 3P+S) for either the serial port or the cassette interface. Signal level considerations are critical. It required an oscilloscope, board changes and some skill to get it working. This is in contrast to Tarbell's board which we have used easily with a number of different recorders.

A bigger disappointment is the fact that the cassette interface cannot read and write at the same time, so this board cannot be used to take full advantage of read-after-write methods of records verification when using professional recorders. We are still looking for the ideal cassette interface board which has digital timing (like the MIO), simultaneous read and write (like the Tarbell), and which has interrupt capability on one or both of these functions to allow read-after-write data verification. An additional port for cassette control status sensing would complete the board. Too many functions on one board (like the MIO) leaves too little room to do any of them really well.

I have seen deficiencies in component quality, delivery schedules, user documentation and (sadly), design philosophy in many products. I am not picking on Imsai in particular, they are, in fact, among the best. I am interested in seeing product evaluations put in some reasonable perspective. Unfortunately, the details of what some product is supposed to do are unclear until the buyer has paid his money and has the item in his hands, but then it's usually too late. MMM is

the first supplier I have run into who says "If you don't like it, send it back."

Finally, a few thoughts for *Kilobaud*. You state that you are tired of hearing complaints about MMM, such as you have been hearing for the last two and one half years. But this is the first time you have considered telling your readers about it. As a matter of fact, I bought my cards from an ad in the June issue of *Kilobaud*. This is a far cry from Wayne's assertion that *Kilobaud* was going to be the watchdog of the micro market and "tell it like it is."

After being at this for two and one half years, as you say, you must have heard plenty about many companies. Keeping it under your vest serves nobody. Let us hear about it, so that readers and suppliers alike will be stimulated to rebut or clean up their acts. Everyone will benefit.

Dr. George Potor Jr.
Fairborn OH

Reader Comments on Cassette I/O Format

You called for comment on McDonough & Hammontre's article "Cassette I/O Format" in Issue #8 (Aug '77). Here's mine:

Yes, the Intel loader/punch format is quite weak, and 8080 owners may be casting about for something a little better. Certainly, the Eby format does provide more flexibility and much better security against bobbled bits. However, for a hobby-level standard, it seems to me to be heavily freighted with overhead, making its loader and punch routines awkwardly long and more elaborate than necessary for the ordinary business of program saving and interchange.

A couple of years ago, the hobby-oriented manufacturers and editors got together in Kansas City and settled on a hobby-standard cassette recording system

which — by not putting any state-of-the-art strain on the hardware or the medium — was and is quite reliable: sufficiently so that elaborate error-detection/correction schemes in the data format are not really needed. A checksum, or at most parity + checksum, is plenty. (Yes, I know. Not *everybody* agreed on, or was even consulted on, the "Kansas City" standard. I wasn't consulted on the length of the meter, either.)

But now we have Eby saying, in effect, "I don't care for the recording standard, I prefer Tarbell. And I am proposing a new universal data-format standard, complete with special formatting to accommodate Tarbell requirements." Well, peachy-keen — but it strikes me that anyone looking for support for a "universal" data format standard is getting off on the wrong foot by proposing that it be specially gussied up for the unique requirements of vendor X's hardware built outside of the only existing hobby "standard." It seems to me that the preamble to any standard should be an oath of allegiance to the idea of standards — including those that didn't happen to be invented by the author.

There are synchronous transmission protocols calling for a whole long string of sync-bytes ahead of the transmission. A universal standard should certainly throw them in too.

Actually, the probability of establishing a universal standard hobby level data format is diminishing. The proposed format is one for the interchange of *machine-language* records. For BASIC, FORTRAN or FOCAL, you just don't tell the machine what address you want the data loaded at. And whose BASIC has a TLOAD which counts bytes and computes checksums? The high-level languages are the only medium approaching a universal hobby-level interchange. And, as Whipple and Arnold can testify, simple, old ANSI BASIC is entangled in compatibility problems,

even when the CPUs are the same for sender and receiver.

Would it be of any benefit for the F8 user to adopt a data-format that would guarantee his ability to load giant quantities of data bits punched up by a 6502? Would the 6800 owner buy himself anything by working up a loader program that would put Processor Tech's 8080 op/codes for their TARGET program into his 6800 memory? Hardly. So the very most that could ever develop, as I see it, is the possibility that the feeblest of the now-standard data formats (Intel's) might ultimately be replaced among 8080 owners by Eby's super-freightliner format or something like it. There are a lot of us in the middle ground, though — 6800 owners with the Motorola-format punch and loader already resident in Motorola's MIKBUG ROM — who are under no compelling need to get anything much better.

The recognition software for the Motorola preamble (S0, S1, S9) has about one chance in 16,000 of being triggered by a random scramble of bits to throw a block of garbage into memory. The Motorola-format address block is no more secure than Intel's, and so can throw a block of data into the wrong place before getting caught if the input data is not software-buffered (MIKBUG loads directly to memory, so if there's a bum bit in the address block, it's too late by the time the checksum detects the error). And, of course, Motorola's 8-bit checksum can be fooled. So it's not perfect, by a long shot. But with a hardware-and-medium-tolerant cassette interface, the raw error rates are quite low, and the number of uncaught errors is well buried in the other noise of programming errors, switch-bounce and intermittent memory chips — that is, at a very low and tolerable level in a well-built system.

The Motorola data for-

continued on page 17

THE HEATHKIT FORUM

Charles Floto

This month I'd like to comment on two interesting letters from Arizona. John M. Blalock writes: "Don't have specs on Heath bus yet, but if anyone can get us away from the Altair bus, I guess Heath can. The H8 front panel beats Altair's, but who needs it? I'd prefer that serial + parallel I/O came with H8, with the panel as an option."

John's first remark is somewhat controversial. Several people told me before Heath's 8080 bus was announced that they hoped it would be compatible with all the boards they'd invested in already. Heath's Director of Computer Products, Lou Frenzel, explained at the National Computer Conference that the Altair-style bus was not considered cost effective, as it has technical problems and uses expensive connectors.

John brings out a good point with his second comment. Most of us want our computer systems to have full alphanumeric input and output capability. Without it, we'd be limited to programming in machine language. Heath recognizes this to the extent that their "minimum recommended H8 system" includes the H9 video terminal. They include software with the H8 called BUG-8, which allows a terminal to perform the functions of the front panel. This suggests there might well be sufficient demand to justify a plain panel version of H8 for people like John.

The other Arizona letter came from Gerald F. McKee: "I am a computer enthusiast, as well as an amateur/commercial broadcast engineer, so I am interested in any items Heath may place upon the mar-

ket, but I would never buy *anything* first run from them again! After experiencing failure of every single Heath I have attempted over the past 22 years (more than \$3870.00 of purchases/repairs and even requests for aid) I'm very gun-shy Come to think of it, I did have one item deliver the goods . . . the Cantenna."

This is a rather paradoxical dissent from the enthusiasm described in the last Heathkit Forum. It almost makes you wonder if Heath products are so habit-forming that even dissatisfied customers come back again and again. Rather reminds me of the fellow who knew he could give up smoking because he'd already done it 20 times.

Of course I do know people who have had trouble putting Heathkits together. They seem to feel the Heath Company lived up to its "We won't let you fail" pledge. Incidentally, while retail stores account for only half of Heath's sales, they're credited with providing 80 percent of the post-sales support. Heath has taken steps to prevent some possible assembly problems with their com-

puter products. The H9 video terminal control board as well as the H8 and H11 CPUs are being shipped fully assembled and tested.

Apparently Heath doesn't share the enthusiasm I expressed for the idea of interfacing their computers to other Heathkits. I'm told they have no current plans along this line, preferring to use microprocessors in dedicated applications within future offerings. This leaves a wide field for *Kilobaud* readers to explore and report on. Let's hear from you! I do understand future Heath TVs will provide for direct video input. Wouldn't you like to have a color monitor?

By now I hope some of you have an H8 up and running. Tell me when you got yours going and we'll see who was first. What have you done with it so far?

Perhaps you haven't quite made up your mind about the H8 and aren't sure you want to lay out \$25 (plus shipping) for a set of manuals. If you have a question, send it along to:

Heathkit Forum
c/o Charles Floto
267 Willow Street
New Haven CT 06511

EDITOR'S REMARKS

from page 3

Santa Maria on the weekend Winthrop was arrested. Ron Yager (vice-president and corporation secretary) joined the company on June 9th. He had been acquainted with Winthrop before that time and had done some work for him. As a matter of fact, he took the photographs of the memory and "monitor" board for the advertisements. Not having a hardware background he was unaware anything was amiss with the boards.

Dennis Levinski (manufacturing VP) came on board June 6th and David Faiman (VP, software

development) was with Winthrop for a couple of months before anyone else arrived. As a result, he suffered the most. You see, David is very sharp in both hardware and software development (he's the designer of their new, and real, 16K memory board). Because of this, Winthrop made sure that David was kept busy developing software that had the specs changed every few days. A nice way to give a guy an ulcer . . . especially when you keep reminding him of an upcoming deadline on a daily basis.

Winthrop left the people at DataSync with something I'm sure he never intended to leave. He left them with a sense of purpose and unity. They want very badly to bring the name of their company up out of the mud and, therefore, they're try-

ing their best to develop and market at least some of the products advertised. The first one will be their 16K memory board . . . followed by the video terminal unit. After that, we'll see.

The police suspect Winthrop's ultimate goal was to get about \$100,000 in orders (as a result of the ads) and then simply vanish. Indications are that he has been involved in several similar operations throughout the country. The detective investigating the case, Ernie Kappahn (pronounced Ka-pan) would like very much to hear from anyone who has had dealings with Winthrop while he was using the following aliases:

Col. David W. Winthrop - California.

William D. Winthrop - California.

William Frank Northrup - Texas.

Harold Bender - Nevada.

William A. Scoville - Nevada/Arizona (Scoville Automation . . . later changed to National Digital Computer Corporation).

Robert L. Renfro - Georgia (Digi-Tone Communications Corp.).

Winthrop always wanted to get his name in print . . . but I have a feeling this isn't quite what he had in mind!

PUBLISHER'S REMARKS

from page 2

pitch for businessmen. Each commercial has to be worked over and worked

over until it will get attention and tell a story — all in one minute. The television commercials are even more difficult — 30 seconds. Try to get the excitement of microcomputers across cold in 30 seconds and see what you come up with!

Each magazine and newspaper ad had to be fitted to the readership of the medium. No use running a business ad in an underground student newspaper — or a hobbyist ad in *Time*. And even with a \$100,000 ad budget we had to watch every part of the package closely, cutting here and there to stay within the budget. Show biz.

Fortunately I've been writing magazine ads for years — and before that I was in both radio and television — so none of it was particularly new. That didn't make it easy; there is no easy way to turn out good ads — they take a lot of time and hard work.

Other details are fun; the Computermania hats for the officials of the show so people could recognize them at a distance; the commercial HTs for radio coordination; the Computermania T-shirts (I think you'll like 'em); and so it goes. Tickets — for attendees, for half-price kids, for the press, for exhibitors, for VIPs — bumper stickers... did we forget anything?

Even with all this excitement life must go on — the next issue of 73 has to go to press; I have to give a talk to the Quarter Century Wireless Association in Seattle; go to New York for the Radio Shack unveiling of their TRS-80 computer and a business meeting with a printer; buzz down to Boston to see how the Personal Computing show is going at Boston University; make a quick trip to northern New Hampshire to visit my folks for an evening; an interview for a newspaper article; buy a van to use as a traveling office so I can keep working on these trips to Boston — that'll give me three more hours of work a day to read manuscripts, answer letters, write editorials, newsletters, etc.

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PCC Lives

One of the first, if not the first, of the people-oriented computer publications is the *People's Computer Company (PCC)*, a newspaper-format publication aimed primarily at school use of computers and emphasizing games and the fun of computing. They've recently shifted to the more standard 8½" x 11" format and taken on a new editor — a sharp one — Phyllis Cole. At \$8 per year (6 issues), it is a good bargain. They print a lot of shorter programs, reviews of equipment and books, etc. You'll like it. *PCC*, Box E. Menlo Park CA 94025.

AROUND THE INDUSTRY

from page 15

mat formally defines only

Header (S0), Data (S1) and End of File (S9) records. In my system, I've also implemented End of Section (S2) for modular records. There's nothing to prevent development of another half dozen conventions among Motorola and AMI 6800 owners (with or without leadership from the manufacturers) linking loader keys, absolute address lists, record-numbers, file numbers, continuation keys — all without affecting bi-directional compatibility with all simpler systems using the same nominal format. I've added binary load & punch modes to my loader (using T0, T1, T2 and T9 preambles), so I can handle either the 2-for-1 hex/ASCII format or the faster 1-for-1 binary format without changing loaders. SWTPC has used a similar X-headed format for the same purpose (unfortunately, they also fiddled with the ground rules for the checksum, so the Motorola algorithm rejects their X tapes).

The need for data interchange among hobbyists is negligible ("Dear Joe: Enclosed is a cassette of the Southgate raw census data. Please do the reduction and demographic charts ASAP, as both candidates are ready to start the primary campaign. Format is Eby standard, of course..."). The need for a new standard for program interchange is inversely proportional to the adequacy of existing systems — and only 8080 owners seem to be suffering very much at the moment.

As far as data handling within a single system is concerned, there's no need for a standard at all. If you are an employer with ten programmers on the staff, yes, you need a standard with which consultants, replacement programmers and hardware troubleshooters are familiar. At the hobby level there is only one person who needs to be conversant with the data format, and that person is also the consultant, the

boss, the lead programmer and the fix-it guy with the soldering iron. When he sells the system, will the genuine Eby-standard data-handling protocol in the operating system have much effect on the negotiated price?

Even for a proposed standard to become widely accepted in the area where it's most needed — program interchange between 8080 owners — a much less elaborate system, preferably one somewhat compatible with the old Intel format, would stand a much better chance than the Eby.

Geoffrey A. Gass
Portland OR

LEGAL/ BUSINESS FORUM

from page 4

lar to those of the articles of association.

However, most states that have nonprofit corporation laws require that the articles of incorporation contain certain provisions and that such document be filed with the secretary of state or county clerk for the county in which the corporation has its principal place of business. Because the requirements for organizing a nonprofit corporation are more stringent than for an unincorporated association, an attorney should be consulted regarding the decision to go the nonprofit route.

The advantages of incorporating are that such an organization is recognized as a legal entity and its members are not liable for the negligent acts of other members. In some states even the members of the board of directors are not personally liable for actions taken by them, barring fraud. A nonprofit corporation is generally exempt from any state income tax. In addition, such corporation may qualify as a tax-exempt organization for

purposes of the Internal Revenue Code. If such an exemption is obtained, contributions to such organizations (even dues) are deductible for income tax purposes.

Licenses and Permits

There may be both local and state licensing requirements. The club may be subject to fines if the proper licenses are not first obtained.

For instance, some municipalities require a license if a club charges admission to an event (i.e., a fund raising dinner or lecture). A building permit may be required if the club plans to build a clubhouse or modify an existing building to be used as one. The post office provides low-rate mailing privileges to qualifying organizations, but the proper permit is required. The club may be required to file a fictitious business name statement. Being granted the privilege of operating as an unincorporated association or nonprofit corporation is also considered a license. A list of the various licenses required can usually be obtained from a local license bureau office.

Conclusion

While the above discussion has been general at best, there are a few important considerations that I hope you will keep in mind. One is that whether your club will be a ten member unincorporated association or a nonprofit corporation with thousands of members, you should have written articles and bylaws. By writing it out you will force the club organizers and members to consider and discuss how the club is to be run. Further, there will actually be something to refer to when a question arises.

A second important point is that the law does vary from state to state.

Before determination is made as to the form your club is to take, you should consult an attorney. You don't need to have him draft your articles of association, but you should have him review the final draft. If you decide to form a nonprofit corporation it is even more important that you consult an attorney as there are more formal requirements.

A third point to remember is that every state and municipality has licensing requirements of some kind. Make sure you have obtained the necessary permits and licenses before conducting any club activities.

Finally, make sure you have liability insurance. If you ever conduct any special activities, such as a computer show, make sure your insurance covers that event.

Doing things the right way may be time consuming and perhaps more expensive in the short run, but it is worth it in the long run.

BOOKS BOOKS BOOKS

from page 9

to Business and Finance," and another called "Keys to Home Management") to any other calculator is a time-consuming bore to anyone who is not turned on by elementary algebra exercises.

What I ordered was a "Source Book" (TI's description) without the wide margins, self-serving fillers and nostalgic plates. What I got brings back those long-forgotten dreary days in high school algebra class. Absolutely no attempt at a quick reference book is made here. It's clearly tutorial and at least twice the size and price that it should be considering the information it contains. Even the pages aren't numbered consecutively. Each chapter has

its own numbers, preceded by another number. This adds to the confusion and leads me to speculate that this is a hasty compilation of several authors' works.

If you happen to like elementary textbooks and you're not too turned off by attempts at humor in that context; if you bought your calculator to learn about math instead of to forget it (as I did); if you appreciate antique book plates; if you intend to give it to your medium-bright ten-year-old child (I finally did); or if you just happen to support mediocrity in general, then buy this book. Otherwise, wait a while. Something better has to come along.

Michael D. Hilker
Yucaipa CA 92399

Programming Proverbs
Henry F. Ledgard
Hayden Book Company,
Inc.
Rochelle Park NJ

One of the fascinating aspects of owning a computer is being able to program it to do a variety of things, and if you haven't yet tried creating your own programs you have missed a lot of fun.

Now that you've joined the rapidly growing ranks of novice programmers, your next step is to become more efficient at creating useful programs; and here is where you need a few useful references. In my search for such references, I lucked onto *Programming Proverbs*. The soft cover looks much like that of an old fashioned almanac or cookbook thus complementing the title. For the novice or even professional programmer, the author has compiled a number of useful rules, or proverbs. The rationale for each is concisely explained, and specifically illustrated in two different programming languages, using a "do and don't" format. Although the languages employed are PL-1 and ALGOL-60, I found this a minor distraction, even for a

BASIC-oriented novice, because the explanation for each proverb is so clearly written.

The book suggests that it is actually possible to write a correct program the first time, and save large amounts of debug time otherwise required. Since I'm essentially lazy, this concept had considerable appeal, and may have favorably influenced my reaction to the text. The book is easy for a person with at least some interest in the subject to read, and contains helpful material. For anyone who plans to do his own programming, I highly recommend this text as a personal reference. Of course, it is of even greater value to those with a knowledge of either PL-1 or ALGOL-60.

W.O. Enderle
Elgin AZ 85611

NEW PRODUCTS

from page 8

rows on 0.3-inch centers; no pads are dedicated to either power or ground. However, power and ground bus is generously provided throughout the card. Bypassing locations are provided to assure stability of the two regulators, which can be installed in their special locations. (Note: The I/O size card only has provision for one regulator.)

The memory size card is \$19.95 postpaid and the I/O size card is \$9.95 postpaid. Send MO, check or MC/BA card # to Personal Computing Company, 3321 Towerwood, Dallas TX 75234.

LETTERS

from page 12

have ATN or ON-GOSUB

and does not support string arrays as Altair 8K does. It does, however, have re-number, list with 2 arguments, an excellent line editor, call, formatted output, and of course the disk functions. It also works math to eight digits instead of six. String length is limited only by available memory.

Tom Hegwood
Gautier MS 39553

Response Time from SWTP

I would like to tell you about the prompt response I received from SWTPC on two problems I had with my PR-40 printer. Others may have had the same problems, and if you print my letter I may save them a lot of grief.

My PR-40 was an early

unit that did not include the latest fixes. The problem with the printer was that the wires would randomly push through the ribbon, causing it to jump out of the mechanism and cause a big mess. This was resolved by replacing the 2.2 Ohm resistors with zener diodes on the solenoid driver transistors. I received the diodes

continued on page 116

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You say you're lonely? Your mailbox is always empty and you never get any phone calls? We have the answer for you. Write an article for *Kilobaud* on "BASIC Timing Comparisons" (Issue #6 — June, 1977), and those problems will be gone forever, if our experience is any indication.

The response to our article has been overwhelming! (It was only whelming to begin with, but then we got some more letters.) We expected to generate a lot of interest and controversy with the article, but we were still surprised by the number of letters and calls we got from all over the country. We're glad we wrote it though. If we hadn't, we might have gone through our entire lives without ever getting a letter from Yazoo City, Mississippi. Thanks, Charlie.

Just to remind you briefly, the article was a comparison of how fast the different microcomputer BASIC versions are, as measured by comparing the time it takes

to run the seven benchmark programs we wrote. We went all over the Los Angeles area to run the tests on every microcomputer BASIC we could find. We discovered huge differences in how fast different versions were. The same benchmark program ran in 28 seconds on one system, and 235 seconds on another!

Well, as a result of some more tests we've run, plus other results sent in by readers, we can now say that the same program takes 21.6 seconds on one system, and 2151 seconds on another! No, we didn't forget the decimal point in that last number.

In addition, some interesting points were brought up in some of the letters. Some questions need answering, some second thoughts need to be presented, and some criticism needs to be aired.

A Quick Review

For those of you who don't have Issue #6 handy, let's quickly review what was covered in the first article.

The whole point of using a

computer is to enable you to do things that, without a computer, would be too slow, too inaccurate, or just not feasible. We're disregarding the pure pleasure of playing with one, of course.

Since speed is such a critical factor in determining the value of a computer, you need to have some sort of measuring technique to compare the speeds of various computer systems.

This is done with benchmark programs. After you find a program that is representative of the type of work the system will be doing, you run it on all the different systems being evaluated. Using a stopwatch, the internal clock, or even a wristwatch, you measure how long the program takes to run on each system. This gives some objective data on the relative speeds of those systems *for that type of program*.

But notice that qualification. If you ran some *other* program, the results might be completely different. One


```

300 PRINT"START"
400 FOR K=1 TO 1000
500 NEXT K
700 PRINT"END"
800 END

```

Fig. 1. Benchmark Program 1.

```

300 PRINT"START"
400 K=0
500 K=K+1
600 IF K<1000 THEN 500
700 PRINT"END"
800 END

```

Fig. 2. Benchmark Program 2.

```

300 PRINT"START"
400 K=0
500 K=K+1
510 A=K/K*K+K-K
600 IF K<1000 THEN 500
700 PRINT"END"
800 END

```

Fig. 3. Benchmark Program 3.

```

300 PRINT"START"
400 K=0
500 K=K+1
510 A=K/2*3+4-5
600 IF K<1000 THEN 500
700 PRINT"END"
800 END

```

Fig. 4. Benchmark Program 4.

```

300 PRINT"START"
400 K=0
500 K=K+1
510 A=K/2*3+4-5
520 GOSUB 820
600 IF K<1000 THEN 500
700 PRINT"END"
800 END
820 RETURN

```

Fig. 5. Benchmark Program 5.

```

300 PRINT"START"
400 K=0
430 DIM M(5)
500 K=K+1
510 A=K/2*3+4-5
520 GOSUB 820
530 FOR L=1 TO 5
540 NEXT L
600 IF K<1000 THEN 500
700 PRINT"END"
800 END
820 RETURN

```

Fig. 6. Benchmark Program 6.

```

300 PRINT"START"
400 K=0
430 DIM M(5)
500 K=K+1
510 A=K/2*3+4-5
520 GOSUB 820
530 FOR L=1 TO 5
535 M(L)=A
540 NEXT L
600 IF K<1000 THEN 500
700 PRINT"END"
800 END
820 RETURN

```

Fig. 7. Benchmark Program 7.

computer's BASIC might have a great algorithm for calculating square roots, but very poor ones for the trig functions. Another might have just the reverse. So, depending on what's in your benchmark program, either system could come out looking a lot faster than the other.

The benchmark programs we created were meant to be short, easily understandable, and as representative as possible of the BASIC coding that is commonly used by small computer users. They should give a good idea of how the various BASICs and microcomputers stack up in general.

If you don't do the same types of things in your programs, you'll need to run your own benchmarks to get data that is meaningful to you. But our results should give you a good starting point, and ought to tell you which ones you'll want to look at first. We decided to look strictly at BASIC, since it's the most commonly used high-level language on microcomputers.

Once again, we'll remind you that BASIC's speed is only one of many factors that should be considered when evaluating the quality of microcomputers. You also have to consider such factors as cost, reliability, availability, reputation of the vendor, number of digits of precision, ease of use, compatibility with other hardware and software, loading time, special features, future support, and other things that may be important for your particular needs.

The Benchmark Programs

Let's look briefly at the seven benchmark programs. For more details, see the article in Issue #6.

The first benchmark program is a simple FOR-NEXT loop which makes the variable K go from 1 to 1000. The second does the same thing (logically), but without the FOR-NEXT loop. Note the large timing difference

between these two in the table of results on virtually all systems.

The second program is used as the basis for all the rest of the benchmark programs. We continue to put more and more statements between lines 500 and 600. Each of these statements is executed 1000 times, and we can see how much time is added by inserting each statement. In addition, the last benchmark (number seven) has a variety of statements in it, and is used as our overall measurement of how fast each BASIC is.

The third benchmark adds statement 510, to do a little arithmetic with variables. The fourth one replaces 510 with a similar statement that uses one digit constants instead. Benchmark five adds statements 520 and 820, to do a GOSUB and a RETURN. Number six adds statements 430, 530, and 540, to do a five-time FOR-NEXT loop 1000 times. Finally, the seventh benchmark program adds statement 535, to see how long it takes to do some simply array handling.

Each benchmark program prints the word START at the beginning and END at the end. We measure the time between the printing of the last letter of START and the first letter of END. This is important if you are using a slow terminal (like a teletype), but the difference is insignificant if the terminal is fast.

What's New?

Since the first article was written, we've run the benchmarks on several more systems, and many people have written in with additional results. Let's go down the list to see what's new.

The most obvious new entries are the ones at the top of the list. We've removed the number one and two finishers from the original list, because the first was run on a non-microcomputer (how's that for terminology?) and the second was an integer BASIC.

We'll have more discussion about that later.

This time we're only including microcomputer BASIC interpreters with floating point arithmetic. Some of the other things we encountered are mentioned later. We're dropping integer only BASICs completely.

In any event, we have a new champion! It's Ohio Scientific Instruments 8K BASIC, version 1.0, revision 3.3, when run on an OSI Challenger at 2 MHz. There's an interesting story behind this.

We arranged with Allen Taylor of Computer Power (San Diego) to run our benchmarks on his OSI Challenger. We did so, and were suitably impressed with the 42.2 seconds it took on his 2 MHz 6502A system for benchmark number seven. But a few days later, we heard from Curt Priest and Charley Musselman of Cambridge MA, who told us that all those Challengers the owners thought were running at 2 MHz were really running at only 1 MHz. Here's the way Curt tells it:

"Regarding the clock frequency of OSI-shipped Challengers. Their engineer, Eric Davis, informed me that all OSI Challengers are shipped running at only 1 MHz. All OSI Challengers shipped since some time last year have CPUs and memory *all guaranteed to run at 2 MHz*. The reason Challengers leave OSI at 1 MHz is because 'they run the disk system currently with the clock at 1 MHz.' My system is not a disk system, and even disk systems could be run at 2 MHz for running programs (that don't use the disk)."

It turns out that there's a potentiometer (near the ROM, we're told) that can be adjusted to "soup up" the Challenger. Curt calibrated his against crystal sources to get some precise tests for us at 1 and 2 MHz. He has revision 3.3 of OSI 8K BASIC, and it looks like he may have the fastest microcomputer BASIC interpreter

running in the country. How's it feel, Curt?

The rest of you Challenger owners can catch up, of course, with a little experimentation. We understand that some of the first Challengers don't have this pot on the board, however.

Other New Ones

Second place was also taken over by a new entry. When run at 2 MHz, TDL's Zapple 8K BASIC (1.1) was the fastest floating point micro BASIC we found at the time of our original article. But when it's run at 4 MHz (on an Altair 8800a with a Cromemco Z-80 board and one wait state), it runs a lot faster. Steve Zook of the Computer Store in Santa Monica had to perform some of his electronic wizardry to get this to work a couple of months ago, but by now others may have succeeded without any wait states. If so, let us know your configuration and results.

By the time you read this, the Commodore PET 2001 computer may be available in a nearby department store, but at the time of this writing only some prototypes exist. John Craig went up to Palo Alto to run the benchmarks, and the results were pretty impressive for the revolutionary newcomer in the field, especially when you consider the ten significant digits that PET BASIC handles.

Another interesting new entry is North Star BASIC-FPB. That's the one that uses North Star's hardware floating point board. Quite an improvement over North Star BASIC without the FPB, and Dan Parker of the University of California at Davis tells us that much greater improvements are seen when a lot of number-crunching is done (such as calculating the sine of a complicated expression 1000 times).

A couple of people wrote to tell us about their happiness with a Tektronix 4051 (which uses the 6800 chip).

It's not particularly fast, but Chuck Sheppard of Sunnyvale raved about its other features — 14 digits of precision, graphics, and file I/O handling.

Micropolis BASIC 1.1 (on a Mod II floppy disk system) has become available and is now on the list. It doesn't seem to be a speed-burner, however.

A particularly interesting new entry is the IBM 5100. You've probably seen it advertised on television, and you may or may not know that the price starts at about nine or ten thousand dollars. Buying from IBM has its advantages, but in this case speed doesn't seem to be one of them.

In last place is a system that's primarily of interest for historical reasons. John Ford of Santa Maria wrote to give us the times with his Martin Research MIKE-2, using SCELBAL from Scelbi Computer Consulting. The MIKE-2 uses the old 8008-1 CPU and, not surprisingly, is very slow. John says he can still do a surprising amount of useful work with this system, and mentions the importance of programmer efficiency in deriving the true potential of a given system. He's also honest enough to confess his envy when he sees some of the newer systems.

Comments and Criticisms

We got several constructive suggestions and lots of interesting comments as a result of the original article. There really wasn't a lot of direct criticism.

A letter of great interest came from Bill Gates, president of Microsoft. Bill probably has more interest and expertise in this matter than anyone, since Microsoft wrote Altair BASIC (8080 and 6800 versions), OSI BASIC, and PET BASIC. Let's look at some of Bill's comments, and our responses:

"There are a few things about your comparisons I would like to point out. The

first is that if you are going to let an integer BASIC be compared against other BASICs which have an integer capability, why penalize the more powerful BASIC by using floating point? All of the extended versions of Altair BASIC support the integer variable type. Altair BASIC can be made into an integer BASIC by using a DEFINT A-Z statement at the start. I still think the Apple BASIC would be faster since it has so little complexity to deal with in variable handling, and the 6502 is an inherently faster processor. I was sorry not to see Microsoft's 8K BASIC for the 6502 put into your list. Ohio Scientific Instruments is distributing that BASIC and I encourage you to include it in an update, since I think it will do very well. I wish someone still had a version of Altair 1.0 around to do a comparison with, since that would show how much Microsoft has improved Altair BASIC since its inception."

First, about integer BASICs: It's true — we said in the original article that it didn't seem fair, but that it was still interesting. We've pulled the integer BASICs out this time. This is partly for the reasons Bill mentions, but mostly because not many people seem to be using them. So, Apple BASIC isn't on the list anymore. We'll wait for their floating point version.

We didn't declare integer variables in those BASICs that allowed it because we wanted to run the programs unchanged on all systems if we possibly could. Writing a program that is going to run on lots of different systems requires avoiding as many incompatibilities as possible. As it is, there's no standard BASIC in the micro world. What works on one system doesn't work on another. Regarding Bill's comments on OSI BASIC and the 6502, we'd have to say that the results certainly seem to support his statements.

"Altair 680 BASIC, also written by Microsoft, looks slower than the 8080-based BASICs only because the 680 runs the clock of the 6800 at half its normal speed. Taking the 680 BASIC times and dividing them by two shows that the 6800 instruction set is more speed efficient, albeit less byte efficient, than the 8080 instruction set for programs as complex as a BASIC."

Many people probably aren't aware that the Altair 680 doesn't run at "normal speed." If anyone could modify Altair 680 BASIC to run on another 6800 system that goes at full speed, they'd have a pretty fast BASIC. The differences between the systems (ROMs, I/O structure, etc.) would probably make this a pretty tough job, though. Has anybody tried it?

"The times for the Cyber 174 BASIC suggest that BASIC is a compiler or an in-line compiler. A BASIC compiler equivalent to Altair BASIC is being worked on at Microsoft. Good software takes a long time to complete so I'm not even going to mention any dates, but I will note that we expect it to be about five times faster than the interpretive Altair BASIC we wrote for Mits."

No, TRW Expanded BASIC on the Cyber 174 is a true interpreter. In fact, it was designed with features and functions in mind, rather than speed. The Cyber 174 is simply a very fast giant computer.

Bill's comments about BASIC compilers and in-line compilers (sometimes called "compile and go" compilers) deserve some explanation to those who don't realize the differences. Most versions of BASIC are interpreters. An interpreter reinterprets (or reconverts, if you prefer) each line of your original BASIC program as it is executed. So, if you execute a line in your program 1000 times, it will be interpreted 1000 times.

A compiler works differ-

Software; Hardware	CPU Type	Benchmark Number							Notes
		1	2	3	4	5	6	7	
1. OSI 8K BASIC (ver 1.0, rev 3.3); OSI Challenger @ 2 MHz	6502	.9	4.6	8.2	9.3	10.0	14.8	21.6	b
2. Zapple 8K BASIC (1.1); Altair 8800a, Cromemco Z-80 @ 4 MHz, 1 wait state	Z-80	.9	5.9	13.0	13.5	14.8	22.7	32.7	a
3. OSI 8K BASIC (ver 1.0, rev 3.2); OSI Challenger @ 1 MHz	6502	1.4	8.6	15.9	17.8	19.3	28.7	42.2	a
4. OSI 8K BASIC (ver 1.0, rev 3.3); OSI Challenger @ 1 MHz	6502	1.6	8.9	16.2	18.2	19.7	29.2	42.9	b
5. PET BASIC; Commodore PET 2001 (prototype)	6502	1.7	9.8	18.6	20.4	22.1	32.6	51.3	b
6. Zapple 8K BASIC (1.1); Altair 8800a, TDL ZPU @ 2 MHz	Z-80	1.7	9.5	20.6	21.7	23.7	36.2	51.8	a
7. Altair 8K BASIC (4.0); Altair 8800b	8080	1.7	10.2	21.0	22.5	24.3	36.7	52.4	a
8. Altair 8K BASIC (3.2); Altair 8800a	8080	1.7	10.3	21.4	23.1	24.8	37.3	52.8	a
9. Altair 8K BASIC (3.0); Imsai I-8080	8080	1.6	10.6	22.0	23.7	25.4	38.3	57.1	a
(tie) 10. Digital Group Z-80 Maxi-BASIC (1.0); Digital Group Z-80 @ 2.5 MHz	Z-80	1.8	7.5	21.2	25.1	26.9	40.3	58.5	a
(tie) 10. Altair 12K Extended BASIC (4.0); Altair 8800b	8080	1.9	7.5	20.6	20.9	22.1	37.0	58.5	a
(tie) 10. Altair Disk Extended BASIC (4.0); Altair 8800b	8080	1.9	7.5	20.6	20.9	22.1	36.9	58.5	a
13. North Star BASIC-FPB (ver 6); Altair 8800a, North Star Fl. Pt. Board	8080	1.9	9.1	18.4	18.5	20.9	36.1	59.4	b
14. Altair 12K Extended BASIC (3.2); Altair 8800a	8080	1.9	8.9	21.8	23.0	24.8	39.3	60.7	a
15. Altair Disk Extended BASIC (3.4); Altair 8800b	8080	1.9	8.8	21.7	22.8	24.7	39.6	61.6	a
16. Altair 4K BASIC (4.0); Altair 8800b	8080	1.9	15.1	26.0	28.9	31.7	44.5	62.1	a
17. Compal-80 10K BASIC; Compal-80	8080	2.0	9.3	23.4	24.6	26.3	42.1	65.7	a
18. Processor Tech BASIC 5; Digital Group 8080	8080	3.6	10.5	27.5	30.9	33.2	51.3	67.4	a
19. Compucolor 8K BASIC; Compucolor 8001	8080	2.1	13.1	27.0	29.0	31.3	47.5	67.8	a
20. Digital Group 8080 Maxi-BASIC (1.0); Digital Group 8080	8080	2.2	9.2	26.4	31.2	33.5	49.9	72.3	a
21. North Star BASIC (ver 6); Altair 8800a	8080	2.3	9.5	26.6	31.3	33.7	50.6	73.8	b
22. Poly 11K BASIC (ver 9V27); Poly-88 System 16	8080	2.5	10.2	29.0	34.0	36.5	54.0	79.0	b
23. Altair 680 8K BASIC (3.2); Altair 680b	6800	2.5	16.3	30.7	33.4	36.3	55.9	81.8	a
24. Poly 11K BASIC (ver A00); Poly-88 System 16	8080	2.5	11.3	31.3	36.1	39.3	58.6	87.6	b
25. Tektronix Level 5 BASIC; Tektronix 4051	6800	4.8	14.0	33.0	36.2	40.7	68.8	103.8	b
26. Micropolis BASIC (1.1); Altair 8800a, Mod II Micropolis disk	8080	8.7	19.9	50.4	54.1	58.2	109.9	146.4	a
27. IBM 5100 BASIC; IBM 5100	??	4.0	20.5	56.5	54.3	58.1	87.0	172.8	a
28. Southwest Tech 8K BASIC (1.0); SWTPC 6800	6800	14.9	24.7	96.1	105.3	109.8	174.1	204.5	a
29. Imsai 8K BASIC (1.31); Imsai I-8080	8080	7.5	28.2	66.4	78.5	88.1	140.1	235.6	a,c
30. Imsai 8K BASIC (1.3); Imsai I-8080, 1702 ROM, 1½ wait states	8080	11.5	39	92	110	121.5	191	320	b
31. SCELBAL BASIC; MIKE-2	8008	312	369	460	515	760	1814	2151	b

Note a: Timings done by authors.

Note b: Timings were sent in by someone else.

Note c: This is a modified version of 1.3 that works in RAM. Not yet released by Imsai.

Fig. 8 Benchmark Timings (in seconds).

ently. It translates (compiles) your BASIC program into machine language code just once, and can then be executed. An in-line compiler will compile the program and

then execute it immediately, so you may not even realize that it's not an interpreter. A regular compiler generally saves the translated code (object code) on a tape or

disk file, which can be loaded and executed later. In either event, a compiler generally runs much faster than an interpreter because an interpreter has to continually re-

interpret each line of code. A compiler does this only once.

All the BASICs in Fig. 8 are interpreters. Compilers generally require a more sophisticated computer sys-

tem configuration (more memory, more I/O devices), and so we'll talk about them separately a little later in this article. Bill's final comments:

"Something that should be very surprising about your chart is how close some of the BASICs seemed to be to each other, even some of the non-Altair BASICs. In fact, if you take into account the use of a different processor, the overhead for I/O interrupts and different clock speeds, a number of these independent BASICs take an identical amount of time as one of the versions of Altair BASIC! This becomes more than a coincidence when you consider that a number of signatures have been put into Altair BASIC intentionally and these also appear in the so-called competitive BASICs. Besides comparing apples to oranges and legitimate software to illegitimate software, your article was very worthwhile. I look forward to seeing a complete chart with

arithmetic to be included. We considered this when creating the benchmark programs, but decided not to for these reasons:

1. This would have made the benchmark programs run longer, and we didn't want to tie up the computers we were borrowing any longer than necessary.
2. There are some incompatibilities among different versions of BASIC in the syntax required for these functions, and we didn't want to modify the programs from one system to the next.
3. We didn't feel that it was very common in BASIC programs to do a lot of complex trig functions, for example, in the middle of a loop that is executed hundreds of times. We feel that it's much more common for a BASIC to be slow because of how inefficiently it performs the continual reinterpretation of each line (as we mentioned earlier), and how inefficiently it does the more normal

open to criticism for not programming as efficiently as possible. Maybe we'll try it for a future article, if we can resolve these problems.

We'll say it once again. We recognize that these benchmark programs aren't all-inclusive. But we still feel they give a good indication of the relative overall speeds of the microcomputer BASICs on the market today.

Microcomputer BASIC Compilers

We received results of only two BASIC compilers for microcomputers. Ira Baxter of Software Dynamics sent us the results of their BASIC 1.0, which was run on a Wave Mate Jupiter II (using a 1 MHz 6800). He says it took 30.2 seconds for benchmark number seven. This looks pretty fast, but you have to remember that this is only the execution time. The compilation time is not included.

R. T. Grele sent us the results of Imsai's BASIC-E

ROM. We still haven't found anyone who has been able to get 1.3 to work properly in RAM, which is where most people try to use it. Version 1.31 is what Imsai called their "fixed-up" version of 1.3 that they were running at the Personal Computing Show in March. At that time they told us that they were going to make some more enhancements and release it as a new version "pretty soon". We're still waiting.

Other Results

Several people sent us their results from running the benchmarks on non-micro systems. We'll just briefly list the results for benchmark seven for an interesting comparison.

The fastest interpreter was an unspecified version of BASIC on the Univac 1106, which took .87 seconds. Next was DEC BASIC 17E on a PDP-10, which took .95 seconds. From our first article, TRW Expanded

Software; Hardware	CPU Type	Benchmark number						
		1	2	3	4	5	6	7
BH BASIC (ver 10.01.00); Heathkit H8	8080	3.5	15.6	31.5	34.5	41.4	67.6	97.4
Heath DEC BASIC (01B02); Heathkit H11 without EIS/FIS	LSI-11	1.3	2.0	8.2	10.6	11.2	18.8	24.2
Heath DEC BASIC; Heathkit H11 with EIS/FIS	LSI-11	1.3	2.0	6.7	7.1	7.6	15.5	20.5

Fig. 9. Benchmark Timings (in seconds) of the new Heathkit systems.

only real BASICs on it."

Bill's not nasty enough to tell us which versions of BASIC he feels were stolen from him, so we'll have to leave that as an exercise for the reader. We're continuing to list every floating point interpretive BASIC that is sold as though it's a unique version. If Bill can stop people from selling them through legal means, we'll stop listing them.

More Feedback

A couple of people criticized us for not including more complex mathematics in our benchmarks. They wanted trig functions, square roots, and more complex

things. We realize that this is subject to dispute, but there's only so much you can put in benchmarks if two of the criteria are that they be short and easily understandable.

The other thing that many people wanted to see as part of the benchmark programs was some string manipulation. Quite a few people seem to use micros for text editing, and they want to know which BASICs are good at it. Sorry, but this is the area where there are really a lot of differences in syntax in the various BASICs. We'd have to make a lot of modifications to the programs just to get them to work the same on all systems, and then we'd be

compiler. On an Imsai I-8080 with an 8080 CPU and an Imsai dual floppy, benchmark seven took 72.2 seconds. Using a TDL ZPU (Z-80) and a Digital Systems Dual Floppy, it took 70.4 seconds. These are pretty slow compared with what we would expect from a compiler, but they're a lot faster than Imsai's 8K BASIC.

Speaking of Imsai's 8K BASIC, you'll notice that there is no mention of a new version of it anywhere on the list. We checked with several local Imsai dealers, and as of early July they still haven't received a new version to replace 1.3, which only seems to work properly when in

BASIC on a Control Data Cyber 174 took 1.04 seconds. BASIC on an HP/3000-II ran in about 10 seconds, but a BASIC compiler on the same machine took .52 seconds.

A couple of timings that should make most microcomputer users feel good are 195 seconds on a DEC PDP 8/e Edusystem-25, and 333 seconds on a DEC PDP 8/e Edusystem-20. Our little low-cost systems look pretty good by comparison. One last result is a BASIC compiler on an IBM 1130, which took 18 seconds.

Conclusions

Things are continuing to

improve, both with the hardware and the software. The vendors who are making strong efforts in both areas seem to be having the most success. A few seem to be almost exclusively concerned with their hardware, and as a result their software isn't keeping pace. A good BASIC isn't cheap, and we think a few of these companies are going to regret it in the long run for not having already made a sufficient investment to develop a better BASIC.

Of course, having the world's fastest BASIC isn't a necessary part of a good computer system, but there's such a huge difference between the fastest ones and the slowest ones that we really feel that the ones at the bottom aren't trying as hard as they could. Let's hope the exposure they're getting here will provide a little incentive for improvement.

If we look at the list with the intent of determining which microprocessor chip is

the fastest, we have to agree with Bill Gates at this point and give the nod to the 6502. It's hard to tell how much of its superior performance is due to superior software, but there's no question that it came out on top in our tests. The Z-80 isn't far behind, but has to be run at 4 MHz to make a really good showing. The 8080 is next, but we found a huge range of fast and slow 8080 BASICs. The 6800 doesn't look so good, but certainly seems to have a lot of unrealized potential. And when it comes to the 8008, well, what did you expect?

The Future

What will the future bring? Your guess is as good as ours (maybe better), but it seems safe to say that there will be major improvements. More and more people are competing with new BASICs, and the older ones are continually being improved. Some of them still have a long way to

go. The BASIC compilers that are beginning to become available will certainly have a strong impact before long.

The hardware, of course, continues to improve by leaps and bounds. The prices keep dropping (with some exceptions) while the capabilities keep expanding. In a couple of years we may all be using pocket sized microcomputer systems based on 32-bit CPUs with parity, hardware multiply and divide, and sophisticated languages like APL and PL/I in ROM. It'll probably cost \$19.95 at Sears. Oh, but batteries are not included. Are we exaggerating? Well, we *think* so.

Anyway, things are changing. In a few months or a year, we'll need to do another update on this article. So, if you run into anything we haven't included, send us the results. Let's limit it to microcomputers exclusively this time. Be sure to note the version of BASIC, the hardware configuration (including

clock and memory speeds), and be sure to enter the benchmark programs *exactly* as shown here. If it's a compiler you're measuring, let us know the compilation time as well as the execution time. If you can use a stopwatch instead of the sweep second hand on a watch, that's great. No sundials, please.

So get to work, everybody. Who would like to step up and challenge the performance of the OSI Challenger?

Late Flash!

We just got a call from Charles Gilmore of the Heath Company, who gave us the results of running our benchmarks on the new Heathkit systems (see Fig. 9).

EIS means "extended instruction set" and FIS means "floating instruction set". Both can be obtained as a hardware option.

It looks like Heath has given the OSI Challenger a new number to shoot for! ■

WHAT'S A BOPA?

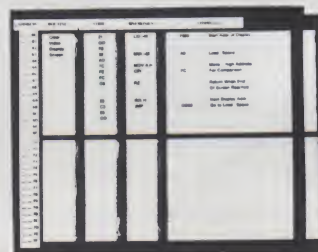
ADDRESS	ROUTINE	CODE	MNEMONICS	COMMENTS
60	Clear	21	LXI—H	F800 Start Addr of Display
61	Video	00		
62	Display	F8		
63	Screen	36	MVI—M	A0 Load "Space"
64		A0		
65		7C	MOV A,H	Move high Address
66		FE	CPI	For Comparison
67		FC		
68		C8	RZ	Return When End
69				Of Screen Reached
6A		23	INX H	Next Display Addr.
6B		C3	JMP	Go to Load "Space"
6C		53		
6D		0D		
6E				
6F				
70				

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H5

Learn and Earn

... BASIC and business programming

Ron has been programming since the beginning of the year. He has developed several small business programs (including a rather impressive cassette oriented payroll package) which will be presented in a series of articles. He discusses not only the application programs but also some of the BASIC commands and their uses. This one takes on the FOR-NEXT loop while offering a rather simple sales receipts tally program (especially simple when compared to his next effort!). — John.

Are you one of my fellow microcomputer buffs who owns his own business and is still using an adding machine and ledger to keep your store records? I previously owned a retail store back before the micro-revolution and totaled up sales receipts every day to keep track of sales income and tax collections made in behalf of the "Governor." I also spent hours making entries and calculations in the "Dome Simplified Book-keeping Record" and hated every minute of this tedium.

When we opened the Computer Radio Workshop last January, I vowed that I wouldn't go through that bookkeeping hassle again.

The computer could do the thinking and calculating, and the cassette recorder could do the recordkeeping. Since *Kilobaud* did not print a complete small business book-keeping system in their first issue, we were left on our own and consequently our goal has not been reached completely. Progress is being made, however, with a payroll and sales income program completed and the program for expense accounts in progress. Some problems with limitations of hardware and software still must be overcome in the expense accounts program.

FOR-NEXT What?

If you haven't been ex-

posed to the BASIC language before, it may be worthwhile to look at lines 190 to 240. This is called a FOR-NEXT loop and the computer will cycle through it for the required number of times called for in the FOR statement. In line 190 we say FOR N = 1 to 999. The FOR tells the computer that we are going to cycle and that it should look for a NEXT statement (if it doesn't find one you will get an error message). The N is any arbitrarily assigned variable and in this case was used to mean entry number. The 1 to 999 tells the computer to count each cycle through the loop starting at 1 and continue to 999.

Thus, on the first time through N will equal 1. As the computer steps through line 200 to 230 it will perform the operations specified. When it gets to line 240 NEXT N, it returns to line 190 FOR N = (to 2 this time) and continues to run this cycle, repeating all operations between FOR and NEXT

again for 999 times. On the last cycle the NEXT statement is bypassed and the computer continues the program starting with the line following (line 250).

The FOR-NEXT loop allows something to be done on a repeated basis. In this case we get an input for amount of sales which we want to accumulate and total. At the Input A statement, the computer stops until A (an amount) is put in. After A is entered we look at it to see if it's 0. If A = 0, then we leave the loop and continue the program at Line 250. If it is not 0, we go to the following line (230) which is a LET statement. This is simply an algebraic expression ($T = T + A$). Since all variables = 0 at the start of the program, on the first time through $T = 0 + A$ where A is the amount you entered. If you entered 10 the first time, then $T = 0 + 10$ or $T = 10$. If you enter 50 the second time, then $T = 10 + 50$ or $T = 60$. On the third cycle, if 12 is entered, then $T = 60 + 12$ or $T = 72$ and so on until 0 is entered or the loop counts to 999. Two FOR-NEXT loops are used in this program.

Several other awesome looking expressions appear at lines 250, 260, 390 and 400. Let's examine line 260 as representative of all of them. This line calculates the 3% sales tax, and in simplified form it would read, LET S = $I * .03$ where S is sales tax and I is income. However, we want to round this value (S) off to two decimal places. Thus we put $(I * .03)$ into Jack Inman's rounding routine and wind up with LET S = INT $((I * .03) * 100 + .5) / 100$. For a complete explanation see *Kilobaud*, April, 1977, page 40.

Program Description

The Program to Tally Sales Receipts is simple and straightforward. It was written with two objectives in mind. First, to accumulate daily cash receipts and income and, second, to prepare

PROGRAM TO TALLY SALES RECEIPTS

BY RON S HARVEY, SR PARTNER
COMPUTER RADIO WORKSHOP
CHEYENNE, WYOMING

ENTER TOTAL AMT OF EACH SALE
? 1130
? 100
? 0
ARE ANY SALES TAX EXEMPT? 1

Display 1. The last entry 0 tells program that task is complete. The 1 after the question indicates a yes response (0 indicates a no).

ENTER TAX EXEMPT AMOUNTS
? 100
? 0
ENTER DATE ? 4,8,77

Display 2. Task complete and date entered (separated by comas).

SALES SUMMARY FOR 4 8 77
TOTAL SALES 1100
EXEMPT SALES 100
NET TAX SALES 1000
SALES TAX DUE 30
TOTAL CASH RECEIPTS 1130

Display 3. Starts automatically after date entered. First four figures entered on sales tax return.

a monthly sales tax return for this cowboy state. It was written to be used on a basic microcomputer system comprised of processor, cassette interface and video based terminal. We are using the Southwest Technical Products Corporation 6800 Computer, CT-1024 TV Typewriter, and AC-30 Audio Cassette Interface and the SWTPC 4K BASIC assembler.

In other versions of BASIC and/or different video terminals, the CHR() function may have to be modified to fit your system. Line 100, for example, performs the "home up" and "erase to end of frame" functions. With the SWTPC CT-1024 Terminal and 4K BASIC, as configured in our system, the ASCII control character for home up is decimal 16 and EOF is decimal 22. However, as these are control characters normally ignored by a Teletype machine, it would only respond to the PRINT and execute a carriage return and line feed.

The program actually

starts at line 180 where the operator is asked to enter the bottom line total of each sales receipt for goods, services and taxes. The use of Print statements in preference to the normal Rem statements is my own idiosyncrasy. If they are not to be printed, they would be left out rather than take up memory or processing time. Therefore, you may wish to change lines 110-170 from PRINT to REM statements.

Line 190 provides for the entry of 999 sales and this can be expanded to meet your requirements if necessary. There is no need to reduce it because escape from this FOR-NEXT loop is provided within the loop (line 220). It is doubtful that the same number of entries would occur every day anyway. After all sales receipts have been entered, the terminal will prompt for the next entry to which a 0 response is given. Upon receipt, the calculation of income and sales tax takes place (lines 250 and 260). Here in Wyoming our

sales tax is 3%. In other states you will have to increase the 1.03 and .03 figures in direct proportion to the inefficiency and mismanagement of your state's fiscal affairs (lines 390 and 400).

Some sales may be exempt from sales tax as in the case of services, goods for resale, or sales to tax exempt organizations. Since these are normally few they have been provided for, when required, at the end of the sales tally. When prompted by the question (line 270), a no response (0) will skip this portion of the program. An affirmative response (1) will require a second look at sales receipts to enter the amounts of the exempt portion of a sale. (If the total sale was exempt, it would have been entered before and still entered in total again at this pass.)

Exit from this FOR-NEXT loop is accomplished in the same manner as previously described in the sales tally (e.g., enter 0 for amount after prompt).

Should your business be primarily service (or tax exempt sales) oriented with a few taxable sales, it may be preferable to provide a double entry (Exempt, Total Sales) at each input prompt. This would be done by deleting lines 260-380, and changing lines 180-250 as shown in Example 1.

After completion of all entries you will be prompted to enter the date. At this point you may wish to stop and set up your cassette recorder to record the Sales Summary which follows rather than copying this information into a ledger. The RETURN after entry of the date will start the summary

```
0100 PRINT CHR(16); CHR(22)
0110 PRINT "PROGRAM TO TALLY SALES RECEIPTS"
0120 PRINT
0130 PRINT "BY RON S. HARVEY, SR PARTNER"
0140 PRINT "COMPUTER RADIO WORKSHOP"
0150 PRINT "CHEYENNE, WYOMING"
0160 PRINT
0170 PRINT
0180 PRINT "ENTER TOTAL AMT OF EACH SALE"
0190 FOR N = 1 TO 999
0200 PRINT CHR(22)
0210 INPUT A
0220 IF A = 0 THEN 250
0230 LET T = T + A
0240 NEXT N
0250 LET I = INT((T/1.03)*100+.5)/100
0260 LET S = INT((I*.03)*100+.5)/100
0270 PRINT "ARE ANY SALES TAX EXEMPT";
0280 INPUT A
0290 IF A = 0 THEN 410
0300 IF A > 1 THEN 270
0310 PRINT CHR(16); CHR(22)
0320 PRINT "ENTER TAX EXEMPT AMOUNTS"
0330 FOR N = 1 TO 999
0340 PRINT CHR(22)
0350 INPUT B
0360 IF B = 0 THEN 390
0370 LET E = E + B
0380 NEXT N
0390 LET I = INT(((T-E)/1.03+E)*100+.5)/100
0400 LET S = INT(((I-E)*.03)*100+.5)/100
0410 PRINT "ENTER DATE ";
0420 INPUT M,D,Y
0430 PRINT CHR(16); CHR(22)
0440 PRINT "SALES SUMMARY FOR ";M;D;Y
0450 PRINT
0460 PRINT "TOTAL SALES",I
0470 PRINT
0480 PRINT "EXEMPT SALES",E
0490 PRINT
0500 PRINT "NET TAX SALES", (I-E)
0510 PRINT
0520 PRINT "SALES TAX DUE",S
0530 PRINT
0540 PRINT "TOTAL CASH RECEIPTS - - - - ";T
0550 PRINT
0560 PRINT
0570 END
```

Program listing. Receipts tally program.

to be printed for a permanent file (magnetic tape or written ledger).

The tax return in Wyoming is a one-page form and does not allow any credit or deduction for collecting sales tax as some states do. The return only requires the

BASICs available is the inability to create a data file that may be recalled on later execution of a program. If this program were to be retained in the computer at all times, the use of GOTO 100 instead of RUN would allow the daily totals to be accumu-

lated (or run) all variables are set to zero. In order to compensate for this limitation, the previous day's Total Receipts and Exempt Sales, recorded on a slip of paper in the cash drawer, must be re-entered (as entry in each category) along with current daily entries. This keeps the tally updated for the final monthly figures.

Retention of accumulated totals is not a serious restriction in this particular program but it is a major problem in the completion of an expense ledger program. It is not an insurmountable problem, however, and one way to overcome it is to dump the entire contents of memory in machine language format to tape. By dumping BASIC plus the program complete with accumulated totals, the soft starting address and GOTO statements will allow reentry to the program where you previously left off. This is reliable but slow way of maintaining program con-

tinuity with variables intact. It takes about 15 minutes to dump 8K of memory at 300 baud (KC standard) and the same time to reload again.

Possibilities that may deserve more experimentation are the use of the input function and Data or Let statements embedded in a Print statement that would cause a new line to be inserted into the program after it is reloaded. These new lines would contain values for variables from the previous run. We have experimented with printing out variable values at the end of a program in a format acceptable to be read back from tape to an Input statement within the program. This is considerably faster than dumping BASIC plus program and even less complicated. The input baud rate is reduced, however, by the necessity for timing loops. This will be discussed in depth in a subsequent article on the payroll program. ■

```
0180 PRINT "ENTER EXEMPT AMT, TOTAL SALE"
0190 FOR N = 1 TO 999
0200 PRINT CHR(22)
0210 INPUT A, B
0220 IF B = 0 THEN 390
0230 LET T = T + B
0240 LET E = E + A
0250 NEXT N
```

Example 1. Modified listing — dual entry.

first four entries found in the summary for our business. In other areas you may wish to add calculations and line numbers for entries on more complicated forms.

Limitations

One of the more frustrating limitations of most

lated for a monthly total. However, in our situation the computer is a demo unit and retention of the program is not practical. I am sure this would be the case in most situations where the computer could also perform other bookkeeping functions. Therefore, as the program

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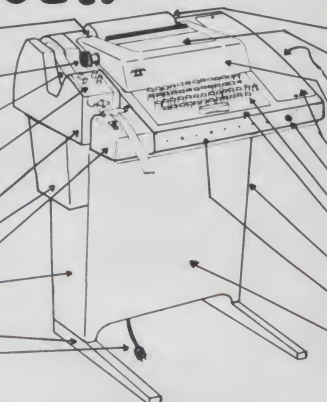
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M24

Bargain Time !

... plenty of power

The word bargain has been used and abused until it is virtually meaningless, but here is a computer related item that I think rates being called a real bargain. The item in question is the CDC minicomputer power supply that is being marketed by Electravalue Industrial, Box 464, Cedar Knolls NJ 07927.

This supply will provide all of the voltages necessary to run most microcomputers. Specifications are shown in Table 1.

Quality, recent-manufacture components are used throughout. The power transformer is a very husky item. I

don't have any requirement for the last three voltages listed, so I disconnected them and probably lessened the transformer load slightly.

I believe the current ratings listed are very conservative. To satisfy my own curiosity I put a 10 Amp dummy load on the +5 V output and a 4 Amp load across each of the 12 V outputs. After fifteen minutes I had to terminate the test, not because the supply couldn't take it, but because the dummy loads were severely overheated. The transformer wasn't as hot as the one in my TV gets and none of the other components seemed

any the worse for the treatment received. None of the output voltages varied at any time during the test.

Features

All of the outputs, except the -6.2, are pot adjustable over a + or - 10% range. The +5 and -12 outputs are over-voltage protected. A special feature is the Power Status Signal (PSS). As long as the +5, +12, and -12 outputs are within 10% of their nominal values, the PSS lead will remain at a logical 1. Otherwise it is a logical 0. This could be used to halt the computer during marginal voltage conditions or to trigger a visual or audible alarm. All input and output leads are fused. A fan mounted on the unit was designed to cool not only the supply but many other logic boards in the minicomputer itself. The ac input line is noise filtered.

The only negative comments I can make about the unit relate to its size and the connectors used. It is long

and narrow (6" x 21½"), which could be awkward if you wanted to mount it inside of your computer cabinet. I believe that power supplies should neither be seen nor heard, so I placed mine under the bench.

I could not mate to any of the connectors provided on the unit so I removed them all. Some were not necessary to my requirements. I bypassed the input connector and ran a line cord directly to the input fuse holder. All output leads are heavy color-coded wire that can be used without the connector or you can replace them with something available locally.

Price for a brand new unit with schematic is \$50 with UPS shipping paid. Hundreds of these power supplies are in stock. Used and defective units are available at lower prices.

Do I really think this is a bargain? The reported original price was \$600 plus. I've ordered another as a spare! Enough said. ■

Input: 110, 120, 220, 230, or 240 volts ac 60 Hz

Output:	Volts dc	Current	Regulation
	+5	8.5 A	5%
	-12	2.0 A	"
	+12	2.5 A	"
	+30	200 mA	15%
	+180	150 mA	5%
	-6.2	25 mA	8%

Table 1.



UP AND RUNNING

TDL EQUIPMENT USED BY NEW JERSEY PUBLIC TELEVISION
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John Montagna, computer engineer (above left), lead this successful network team in generating election results speedily, efficiently and reliably using predominantly TDL hardware and software. Montagna created three programs to get the job done. The text for a SWAPPER program was written and assembled using the TDL TEXT EDITOR and Z80 RELOCATING MACRO ASSEMBLER. The SWAPPER text and all debugging was run through TDL's ZAPPLE MONITOR. The relocatable object code was punched onto paper tape. A MAIN USERS program updated votes and controlled air display. An ALTERNATE USERS program got hard copy out and votes in. The latter two programs were written in BASIC. Montagna modified the ZAPPLE BASIC to permit time-sharing between the two USERS programs.

Four screens were incorporated, two terminals entered votes as they came in and were used to call back votes to check accuracy. Montagna called on the power and flexibility offered by TDL's ZPU board and three Z-16 Memory boards.

Montagna's setup worked constantly for over four hours updating and displaying state-wide and county-wide results without flaw.

"I chose TDL because they have all the software to support their hardware, and it's good; it has the flexibility to do the job."

John Montagna

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Hello!

Today's Program Is ...

... understanding

computer speech recognition

*Sheila Clarke
Cybergrafix
P. O. Box 430
Glendale CA 91206*

The number of people adding speech-recognition capabilities to their computer systems is on the increase. Some hobbyists are giving their computers names to reflect the personalities their talking machines seem to assume. We know of one who calls his "Crazy 80." Many of these "personality computers" are being taught to do some amazing things, and a large number are using the Heuristics Speechlab system.

The value of many special applications may be lost on those of us who have full use of our physical capabilities. But there are those who, because of deafness, cannot carry on a phone conversation, or because of stroke, cannot speak coherently.

One deaf woman is married to a man with normal



The two gentlemen who designed Speechlab and founded Heuristics, Inc., have extensive backgrounds in the study of artificial intelligence. Horace Enea, Heuristics' pro-

Some environments may be noisy because of background conversation. So, to filter out confusion of recognition by the computer, the user can include key words, such as "enter," to begin phrases to trigger speech recognition. To play back the input a key word like "verify" can begin a phrase. If input is incorrect, "erase" or a similar word can permit

To set up your vocabulary, type the word in, then speak the word into the micro-

In simpler language all of that means the board contains a hardware preprocessor with a vast amount of information in acoustic wave form — one quarter of a million bits per second. The preprocessor gathers the data under software control, using



various algorithms.

Heuristics prefers to sell the unit assembled because, though it contains relatively few ICs, the resistors and capacitors are numerous, adding up to over 200 parts. For most hobbyists, the \$50 savings for a kit isn't worth the labor involved. Though the assembly and test manual is complete, we recommend you purchase the Speechlab assembled and tested, so you can get on with the business of teaching your computer to understand you.

All the intelligence of the speech recognition system is built into the software algorithms. The preprocessor

The board contains three audio bandpass filters, a zero-crossing detector, compression amplifier, A/D con-



Left: Horace Enea first types the word that the computer will learn to recognize.

Below: John Reykjalin stands by as Horace voices the same word into the microphone that he has just typed.



and the software algorithms work together in a fully integrated manner, as you can see from the block diagram in Fig. 1.

Along with the 95-page hardware manual is the *Laboratory Manual*, Volume I.

This book has been written for the student of speech recognition, beginning with a thorough discussion of human speech. The 35 experiments amount to a progressive tutorial on the science of speech when broken into components that the computer will understand. Following the experiments are 13 programs in Palo Alto Tiny BASIC, and four programs for implementing SpeechBASIC. This lab manual is the very reason many could become so involved with speech recognition that all other aspects of computing could be set aside for quite a while.

At this writing, Heuristics is producing their second volume of experiments and application programs. The material will be the result of input from Speechlab users — much of it slanted toward business applications. Though much of their engineering time is spent improving the

board itself, most of their effort is invested in new software and applications.

It's Not Perfect

When we first encountered Heuristics at the Computer Faire in San Francisco, everyone was disappointed that, due to the terrific din, the Speechlab could not differentiate between background roar and instructions voiced directly into the microphone. So we couldn't see a demonstration. When asked about the problem later, Heuristics reported that in a normal working environment they

have no problem with noise. As a matter of fact, they haven't had a problem when demonstrating it to the Homebrew Club with over 300 in attendance. But 13,000 people at the Faire created much too high a noise level. To overcome a generally high-noise environment a special microphone, called noise-cancelling mike, is available, but could cost as much as the board itself. Heuristics does offer it as an accessory.

Hobbyist's Point of View

To get a user's point of view, I talked with Ron

Henley in Los Angeles. He was among the first to buy the Speechlab, around March or April of this year. He was extremely impressed when he assembled his kit, plugged it into his computer and it ran. He's performed three or four of the 35 experiments listed in the manual, and rates the documentation as A+ ... comparable to the best he's seen. He felt the documentation was among the outstanding features of the product. He felt also, however, that audio high-level language input is not possible. Perhaps Heuristics would disagree, especially since Ron did not work with the board beyond the first few experiments. Ron agreed with Heuristics that it doesn't make sense to buy the kit when, for \$50 more and a lot less hassle, you can have it running immediately. He also discovered that when teaching the computer to distinguish his speech patterns, he had to be more distinct than he'd expected. As Heuristics put it, any phrase that is one breath group, like, "Open the garage door," is recognized as a single vocabulary entry. And the board handles up to 64 of these vocabulary entries. There are more distinctive sounds in a phrase than in a word, and the chances of computer confusion are greatly diminished when phrases are used.

Just for the record, Speechlab can be purchased from dealers around the country, or direct from Heuristics for \$299 assembled. Heuristics is located at 900 N. San Antonio Road, Los Altos CA 94022.

If you're considering *dabbling* a little in speech recognition, don't. It takes more of a commitment on your part to realize the full benefits of Speechlab. When you get your unit you've only begun. You're then ready to embark on a brand new adventure in hobby computing — one that should keep any hobbyist happily involved for a long, long time.■

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Beware the Altair Bus

... it's not as compatible as you think !

Bill Fuller
2377 Dalworth 157
Grand Prairie TX 75050

I have the feeling this is another of those articles which will generate a lot of interest. If you've had any personal experiences with incompatible Altair bus

boards, jot them down and forward them to Bill (he has already indicated that a follow-up article will probably be needed). Also, if you're a manufacturer pro-

ducing an Altair bus-compatible board and would like to point out any incompatibilities ... then drop a line to Bill too. — John.

Altair 8800B (System)			
Pin #	Mnemonic	Description	Remarks
12	XRDY 2	External Ready 2	
55	RTC	Real Time Clock	60 Hz reference
56	STSTB	Status Strobe	8224 clock IC, 8800B Display/Control Board
57	DIG 1	Enable signal for CPU DI drivers on 8800B	
58	FRDY	8800B front panel ready signal	
Processor Technology Corp. (SOL)			
57	DIG 1	Data Input Gate 1	When low forces PDB INs low and forces CPU input multiplexers to the DIO bus. During CPU DBIN cycle, disables CPU DIO bus drivers
65	MREQ	Memory Request (Z-80)	Not used on SOL
66	REF	Refresh (Z-80)	Not used on SOL
67*	PHANTOM	Phantom Disable	Used to disable RAM or ROM during power on initialization program execution.
* Also used on PTC Co. PROM board.			
Cromemco (Dazzler)			
67	REFR DSBL	Refresh Disable	Prevents dynamic RAM refresh cycles during Dazzler DMA.
Technical Design Labs (TDL) (Z-80 Board)			
4	VIO	Vector Interrupt 0	
4	NMI	Non-Maskable Interrupt	Optional change for the TDL Z-80 CPU board.
98	SSTACK	Stack Status	Not used on Z-80 CPU board
98	REFRESH	Memory Refresh	Optional change for the TDL Z-80 CPU board.
Vector Graphics (Reset and Go Board)			
67	PHANTOM	Phantom Disable	
S.D. Sales (Z-80 CPU Board)			
66	RFSH	Memory Refresh	

In an otherwise excellent article by Mike Smith ("Build Your Own Interface", *Kilobaud*, June 1977) certain overlooked Altair bus designations invalidate the statement that "Table 1 contains a complete breakdown of all the Altair bus signals ...". In fact, even the Altair 8800B additions are not listed.

The only "almost complete" listing is contained in *Dr. Dobbs's Journal*, (August, 1976), as "Proposed Hobbyist Standard* Bus Structure". This article also appeared in *Computer* (October, 1976).

To bring everyone up to date with another list, incomplete as it is, Table 1 (in this article) is provided to cover those "not used" pins of the June *Kilobaud* article. Note that many of the functions are optional for a particular board.

Table 1 primarily addresses those pins undefined in the original Altair 8800 (12 through 17 and 55

through 67). However, some manufacturers have configured their bus such that some functions have been deleted or redefined from the original Altair bus. These changes also are shown in the table.

In putting together a system or using boards from different manufacturers, you need to avoid incompatibility. Perhaps the most obvious conflict in Table 1 is pin 67. Here, four boards use the pin for three different functions (Phantom, NMI, REFR DSBL). Some modifications would be required before a combination of these boards could function together in the same system.

Incompatibility also exists where certain functions are not provided by a CPU board or system. Examples in this category are the Central Data 2650 Computer System and the Polymorphic System. The 2650 System does not generate PSYNC (pin 76) which is used by most of the available RAM boards. The Polymorphic System does not provide for eleven of the Altair bus signals. While many of these are front panel functions, the possibility exists that the deleted signal might be required on boards from other manufacturers.

Considering that over 200 boards for the Altair bus are presently available from a multitude of sources, blindly plugging in a selected combination because they are "Altair/Imsai/S-100/Hobbyist Standard", without checking for actual compatibility can lead to some strange results. For the neophyte it could lead to endless hours of frustration.

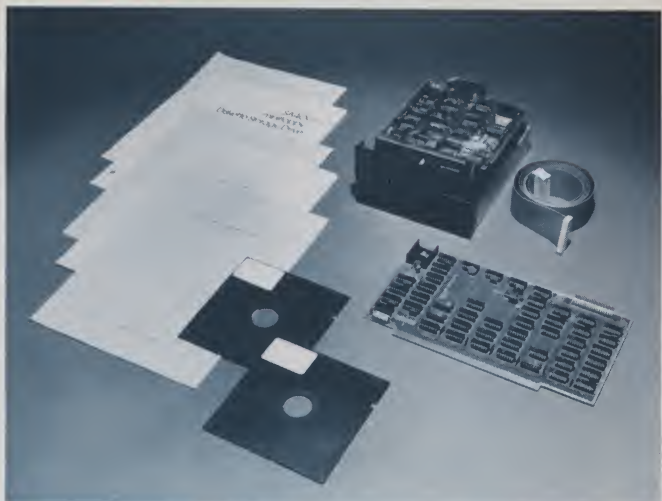
Until a complete list becomes available, if ever, your best approach is to compare signals generated by your system or CPU board with the signals required for the board(s) you anticipate using.

Sources of information are the manufacturers, your local computer store, clubs, or

67	<u>NMI</u>	Non-Maskable Interrupt	Requires cutting trace to eliminate function.
98	<u>DEBUG</u>	Allows jump to address C000.	
98	SSTACK	Stack Status	Not used on Z-80
MRS (6800 CPU Board)			
14	01 Clock	M6800 01 Clock	Jumper optional
15	02 Clock	M6800 02 Clock	Jumper optional
16	<u>R/W</u>	M6800 Read/Write	Jumper optional
12	<u>NMI</u>	Non-Maskable Interrupt	M6800
13	<u>IRQ</u>	Interrupt Request	M6800
Note: 8080 CPU in system controls front panel operations.			
Polymorphics System			
13-19		Reserved for bus control	18-STA DSB and 19-C/C DSB not used at present.
22 & 23		Reserved for bus control	22-ADD DSB and 23-DO DSB not used at present.
26		Reserved for bus control	26-PHLDA not used at present.
27 & 28		Unused	27-PWAIT, 28-PINTE
67	Phantom	Used to disable RAM and I/O addressing	
69-71		Unused	69-PS, 70-PROT, 71-RUN
98		Unused	98-SSTACK
BISI (64K CCD Memory Board)			
13	CK3	Phase 3 shift clock	
14	<u>CK1</u>	Phase 1 shift clock	
15	<u>BWE</u>	Write enable-anded with WRITE	
16	LDM	Load medium address byte	
17	BDSEL	Acknowledge signal from addressed storage board	
62	CK4	Phase 4 shift clock	
63	CK2	Phase 2 shift clock	
64	<u>BCE</u>	Chip enable	
65	<u>WRITE</u>	Write signal	
66	LDH	Load High Address Byte	
Alpha Micro Technology (16-bit CPU Board)			
56	DMAGR 7	DMA Grant 7	All DMA Grant pins jumper selectable. But, pins designated are recommended sequence.
57	DMAGR 6	DMA Grant 6	
58	DMAGR 5	DMA Grant 5	
59	DMAGR 4	DMA Grant 4	
60	DMAGR 3	DMA Grant 3	
61	DMAGR 2	DMA Grant 2	
62	DMAGR 1	DMA Grant 1	
63	<u>DMAGR 0</u>	DMA Grant 0	
64	DMA RCVD	Flag that indicates a DMA is about to happen.	Insures DMA grant.
Central Data 2650 Computer System (2650 CPU Board)**			
12	XRDY 2		Not available (n/a)
21	SS		n/a
24	02		n/a
25	01		n/a
26	PHLA		n/a
27	PWAIT		n/a
28	PINTE		n/a
44	SM1		n/a
48	SHLTA		n/a
53	SSW		n/a
55	<u>RTC</u>		n/a
56	STSTB		n/a
57	DIG 1		n/a
58	FRDY		n/a
69	PS		n/a
72	<u>PRDY</u>		n/a
74	PHOLD		n/a
76	PSYNC		n/a
96	SINTA		n/a
98	SSTACK		n/a

**None of the above signals are available from the 2650 board to the Central Data S-100 Interface Board. Other Altair bus signals are either available from the CPU board or are derived on the S-100 Interface Board.

Table 1.



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N9

NORTH STAR COMPUTERS, INC.
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Berkeley, CA 94710

someone who already has the board or system. ■

References:

Kilobaud June, 1977
Dr. Dobb's Journal August, 1976
Interface Age February, 1977
Central Data Company Literature
S.D. Sales Construction Manual
Alpha Micro Technology — Dick Wilcox

Radio-Electronics April & May, 1977

Companies mentioned:

Central Data Company
P.O. Box 2484 Station A
Champaign IL 61820
BISI
Box 1197, Station A
Vancouver BC Canada
MRS
P.O. Box 1220
Hawthorne CA 90250

Alpha Micro Technology
1342 Mauna Loa Road
Tustin CA 92680

S.D. Sales Co.
P.O. Box 28810
Dallas TX 75228

Vector Graphics Inc.
717 Lakefield Road, Suite F
Westlake Village CA 91361

Polymorphic Systems
460 Ward Drive
Santa Barbara CA 93111

Processor Technology Corp.
6200B Hollis Street
Emeryville CA 94608

Cromemco
2432 Charleston Road
Mountain View CA 94043

Technical Design Labs (TDL)
Research Park Bldg. H
1101 State Road
Princeton NJ 08540

MITs (Altair)
Albuquerque NM 87106

A Response from Michael L. Smith

In response to Mr. Fuller's opening paragraphs, I would like to point out that the bus description was for the Altair bus, not for all the various copies commonly referred to as the S-100 bus.

The 8800B signals omitted from my list of signals are primarily used for the additional functions provided by the expanded 8800B front panel and are not of interest in general interfacing which was, after all, the subject of the article.

As for the other subsets of signals mentioned by Mr. Fuller, it is important to remember that anyone and his brother may add newly defined signals to any bus, but that no one is under any obligation to conform to these unsanctioned standards. For better or worse, the Altair bus designations are controlled by Mits. What do you do when you have built or purchased interfaces using one of the "add-on" standards and Mits redesignates some of the pins you have

used? Remember, it's their bus and they make the rules.

The idea behind successful computer interfacing is to fully conform (to the extent possible) to the existing signals and protocol presented by the bus manufacturer, not to make additional signal designations.

It is not necessarily wrong to enhance the operation of your own system by using additional signals or redefining existing ones, but to refer to every signal that someone adds as a standard misses the point.

One final point... While the Altair bus has many faults, including inconsistent pin-outs within a group of signals, inconsistent signal polarities (most commercial buses have all active low signals), and too much orientation toward the processor (the 8080A), it has provided a means for the hobby market to grow and prosper. This growth has resulted not from the excellence of the Altair bus, but from the fact that it provided a standard. ■

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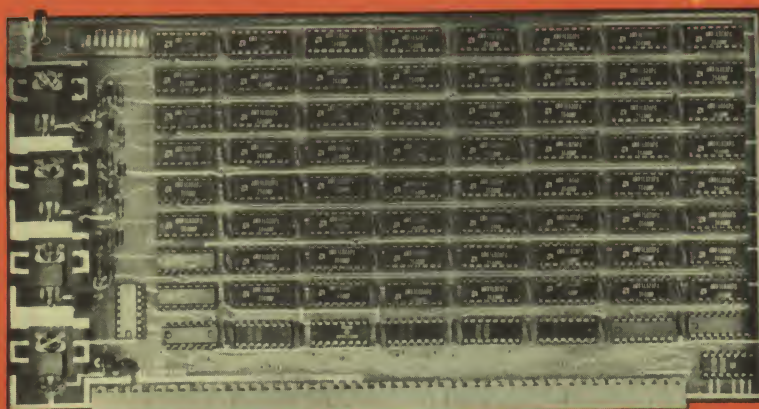
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Put Your Imsai on the Rack !

... it's not torture

Don discusses several modifications he has made to his Imsai in the following article . . . including brackets for rack-mounting. Those of you interested in going this route might want to check into Imsai's new rack-mount cabinet (which can be purchased separately). I've seen it . . . and it's as rugged as a tank! — John.



Photo 1. Unpacking the Imsai 8080 kit.

Well, I finally did it. One lovely summer day I walked into the friendly local computer store and bought the microcomputer kit I felt would fit all my computing needs. Christmas in July continued while I unpacked the Imsai 8080 kit parts (chassis sheet metal parts, small boxes of parts, and manuals). After I had made a quick visual check to make sure all the major parts were there, my understanding wife reminded me I had promised her we would spend the rest of the weekend at her folks' cottage swimming, sailing, and waterskiing (not putting a computer together). Well at least I could take the manuals along to look over so that I could start assembling the kit later.

Sunday night came and I started calming down after thoroughly rereading the Imsai 8080 assembly manuals. I guess I have been spoiled by the assembly and technician people I have worked with. They had done a lot of work building and debugging the mini and microcomputer hardware before I could start adding the systems and applications

software to the computer systems. Getting into the hardware end of computers was going to be a little more work than I had realized. But then, jumping in and doing is how I learned electronics (building and debugging radio receivers, transmitters), photography (camera and darkroom techniques), computer programming (as a university student, and as an employee of computer firms), video terminals (building and modifying SWTPC CT-1024 terminal system), and now the hardware end of small computers.

Since it's a little late for a new product review, I will concentrate on sharing the assembly hints and kinks I ran into, and describe some mechanical and aesthetically pleasing modifications that I made to my Imsai 8080.

Assembling the Imsai 8080 was really not difficult. Table 1 summarizes the time it took to assemble each part of the kit, as well as the time it took to assemble two Godbout 4K RAM boards and a Processor Technology 3P+S I/O interface board. During assembly each board was checked both visually (for missed soldering

points, solder splashes etc.) and electrically (pre-assembly check of capacitors for shorts, shorted or dead diodes, and ball-park resistance values as marked on the resistor body). These extra steps are well worth the effort and may save you from hunting down a hardware bug caused by a component that was bad before being assembled.

Assembly Kinks

The only real problem I ran into while assembling the Imsai 8080 was with the documentation for the proper placement of the ± 16 volt diodes CR4 — CR7. More recent models have the whole power supply (including the power transformer and ac line noise filter) on one printed circuit board. Apparently the parts placement diagram for the power supply PC board hadn't caught up with this change. The diagram called for all of the diodes to be mounted on the same side, which did not look right to me. The schematic and accompanying photographs of the power supply PC board confirmed my suspicions. The schematic and photographs were correct. Diodes CR4 and CR7 should be mounted as shown in the diagram. However, CR5 and CR6 should be mounted on the PC board with the band on the diode's body at the top, but placed across from diodes CR4 and CR7.

There was another trivial documentation problem with the power supply parts placement diagram. The assembly text designation of the ± 16 and +5 volt filter capacitors and the designation of these parts on the diagram didn't agree (referring to Photo 4 — from right to left, they are C1, C2, C3, C4). However, this problem was much simpler to figure out. Hopefully, both errors in the power supply diagram have been corrected by now since I (and I would assume other owners) have advised IMS Associates of the errors.

Operation	Time in Hours
Unpack and check parts	1
MPU PC Board Assembly	3
CP-A PC Board Assembly	4
Power Supply PC Board Assembly	3
Backplane Assembly (22 slot PC board)	5
Chassis Sheet Metal Assembly	1
Debug CP-A PC Board	5
Total time spent assembling the Imsai 8080	22
Godbout 4K Econoram PC Board Assembly (Board #1)	4.5
Godbout 4K Econoram PC Board Assembly (Board #2)	4
Processor Technology 3P+S Interface PC Board Assembly	5
Total time spent so far	35.5 hours

Table 1. Breakdown of assembly time for an Imsai 8080 system.

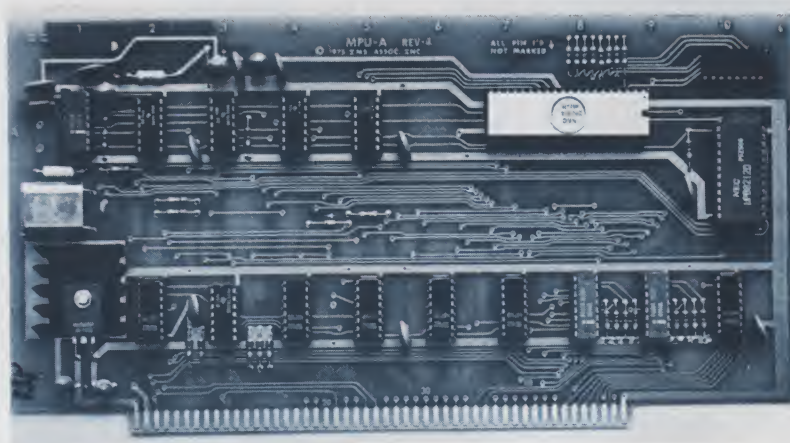


Photo 2. Assembled Imsai 8080 MPU printed circuit board.

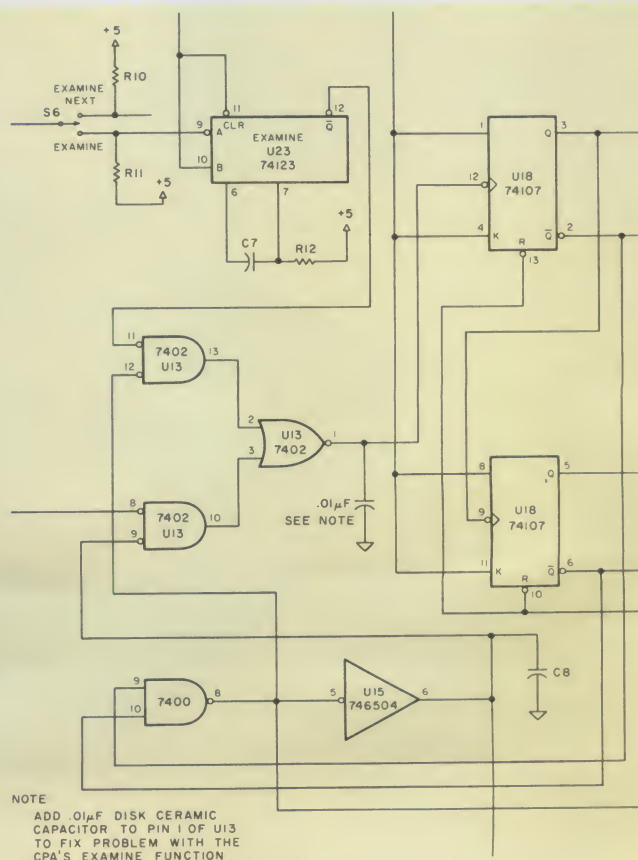


Fig. 1. Modification to the Imsai 8080 CP-A circuit.

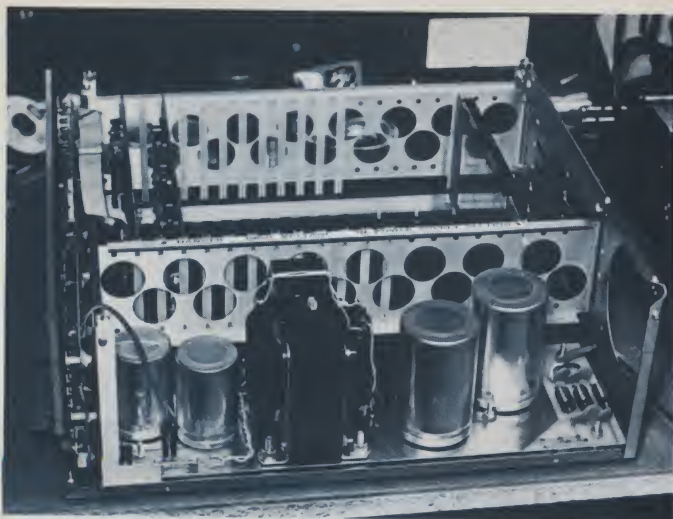


Photo 4. Inside view of the Imsai 8080 showing the use of Molex connector pins being used for disconnecting the ac switch leads from the power supply printed circuit board.

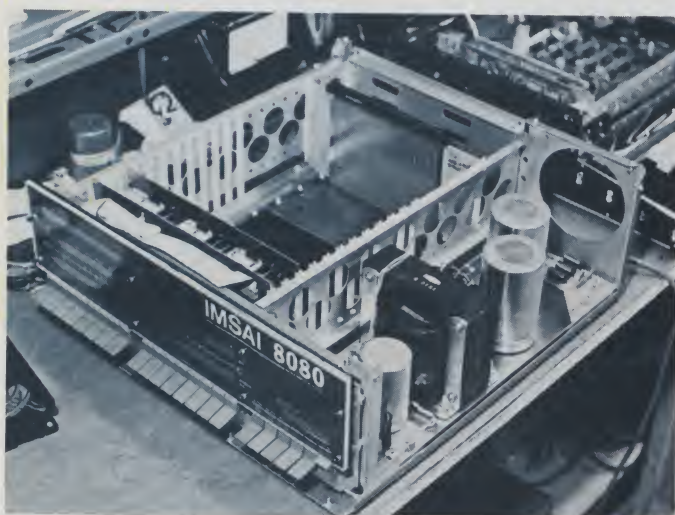


Photo 5. Inside view of the Imsai 8080 at initial checkout. Note neat chassis layout.

Assembly Hints

It seems that every time I finish a kit or project there is something I would have added or done differently during assembly, and this was the case with my Imsai 8080. However, since I have already found some good assembly hints, here they are.

I am a firm believer in using IC sockets in all my projects and my Imsai 8080 was not going to be an exception. But I realized that the CP-A PC board (programmer's console) was going to require low profile IC sockets. Otherwise, if the ICs were mounted in standard sockets, the front panel photomask-plexiglas would not sit flat against the nylon standoffs which separate the panel from the CP-A PC board. Hence, low profile IC sockets are a must on the CP-A PC board. An added advantage of low profile sockets is that even ICs mounted under the front panel paddle switches could be removed and inserted without too much trouble, which would have been impossible with standard sockets.

The CP-A PC board plugs

into an edge connector on the backplane and is separated from the sheet metal backplate of the chassis and the photomask-plexiglas front panel by nylon standoffs. It is difficult to line up the retaining machine screws through the plexiglas panel, a standoff, the PC board, another standoff and into the backplate. And of course there are eight screws. To avoid total frustration simply rough up the edges of the standoffs with sandpaper and glue them onto the PC board with fast-curing epoxy, taking care that the holes in the standoffs line up with those in the board.

This hint will save time when removing or installing the programmer's console. Instead of soldering the two insulated ac switch wires to the power supply board as the assembly manual instructs, solder a female Molex connector pin onto each wire and cover each with a length of heat-shrinkable tubing. Solder male Molex pins where the ac switch lead wires connect to the power supply board. This arrangement allows CP-A PC board assembly to be removed or reinstalled by simply disconnecting the ac switch wires. If you mount a fan in

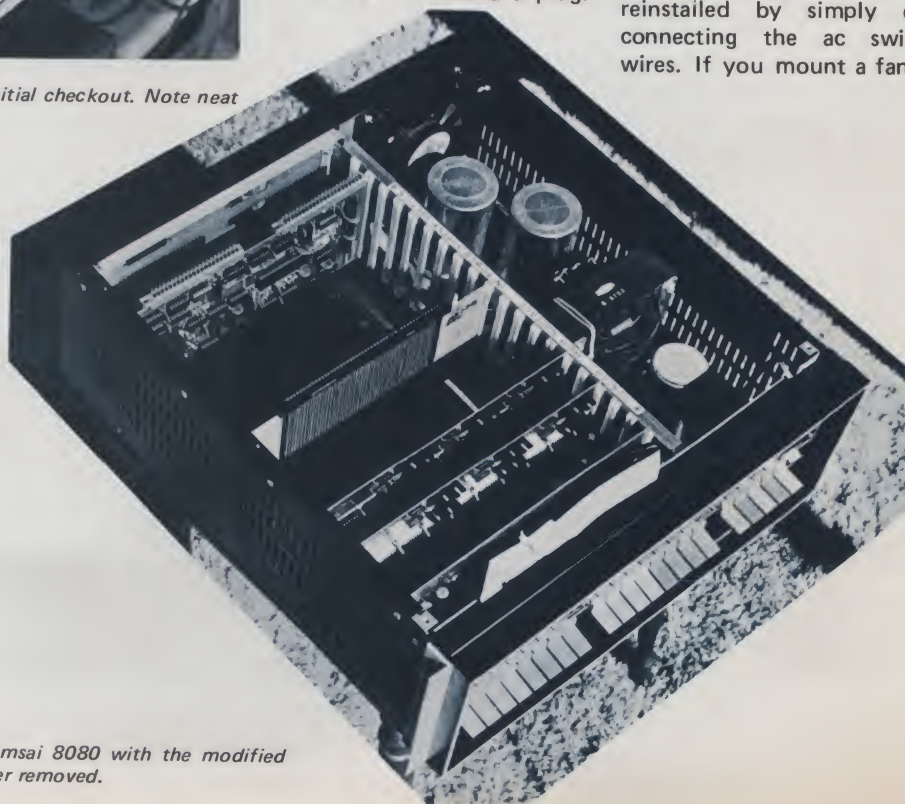
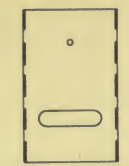
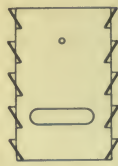


Photo 6. Inside view of the finished Imsai 8080 with the modified cabinet installed, but with the access cover removed.

HEAT SINK FOR 7805 TYPE VOLTAGE REGULATORS



UNMODIFIED HEAT SINK FINS



MODIFIED HEAT SINK FINS, BENT AT A 45° ANGLE

UP

HEAT SINK IS USUALLY MOUNTED ON A P.C. BOARD WHICH WILL BE IN A VERTICAL POSITION WHEN INSTALLED IN THE COMPUTER SYSTEM (IE. ALTAIR, IMSAI)

Fig. 2. Modifications to the heat sinks on the Imsai 8080 printed circuit boards.

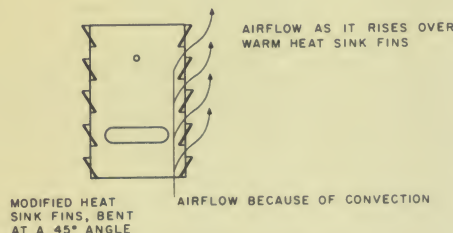


Fig. 3. Airflow over modified heat sinks.

your Imsai 8080, you can also use Molex connectors on those ac power leads.

Another hint is to buy the 22-slot backplane (mother board) and populate it with at least 20 edge connectors while you are building the Imsai 8080. I think you will quickly find that you have outgrown the 6-slot mother board that comes with the kit, which means that you will want additional 4-slot boards or the 22-slot mother board later. You might as well save time and go with the 22-slot mother board to start with and install at least 20 edge connectors since you will probably end up doing it later. You will have to unsolder the ± 16 , +5 volt and ground line and remove the backplane. Then solder in the edge connectors and reinstall the backplane, resolder the power and ground lines, and install the programmer's console. A system with a 22-slot backplane should have a higher resale value.

Hardware Debugging

Initial checkout went well until I found that the examine switch function would not work properly. Searching with a logic probe and oscilloscope, I found that with the logic probe on pin 1

of U13 on the CP-A board, the examine switch function worked perfectly. I tried a .01 μ F disk capacitor from pin 1 of U13 to ground (see Fig. 1) which cured the problem. Apparently the capacitor stretches the pulse from the IC long enough for the flip-flop to catch up. This is an educated guess since I am not that good at digital logic.

The only other hardware problem I have is in the ac line noise filter on the power supply board. The filter area has a 60 Hz mechanical hum even when the system is shut off (but with the ac line cord plugged in). I tried epoxying the air wound coils of the filter, thinking that perhaps the alternating magnetic field was making them vibrate. However, this approach didn't seem to help much. Since the hum is covered by the sound of the muffin fan, and changing the capacitors may not help, I'll live with it for now.

Maybe We Could Make Some Improvements

The Imsai 8080 is a reasonably well-designed machine, but as any engineer, musician, or artist will tell you, somebody will always come up with what they think is an improvement. So,

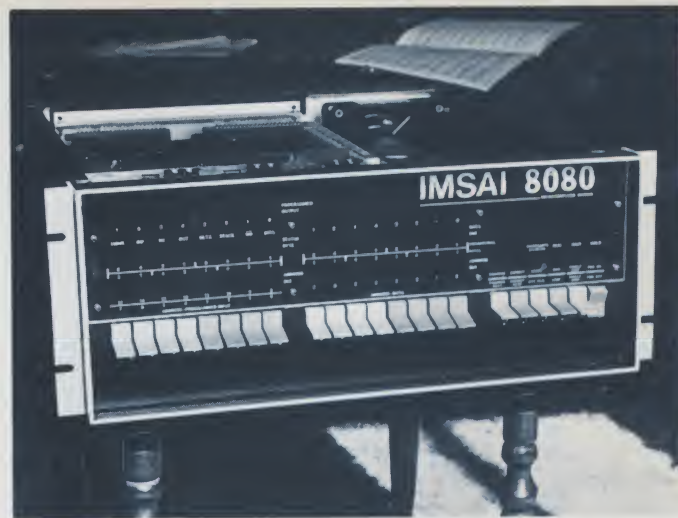


Photo 7. Front view of finished Imsai 8080 with modified cabinet installed, but with the top access cover removed.

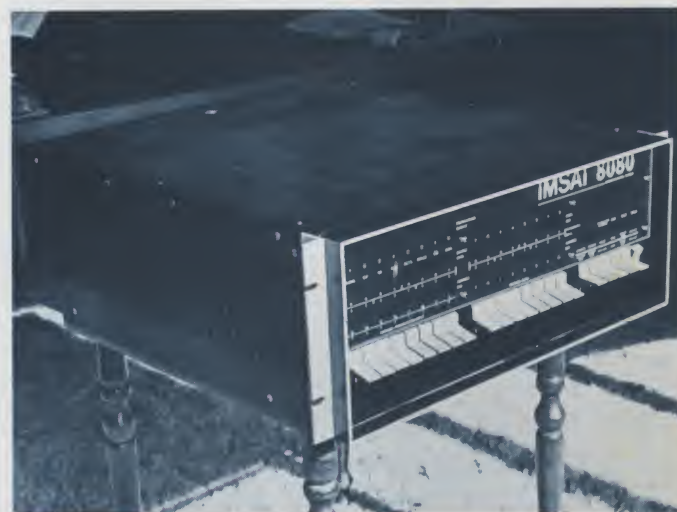


Photo 8. Front view of finished Imsai 8080 with modified cabinet installed and the top access cover installed.

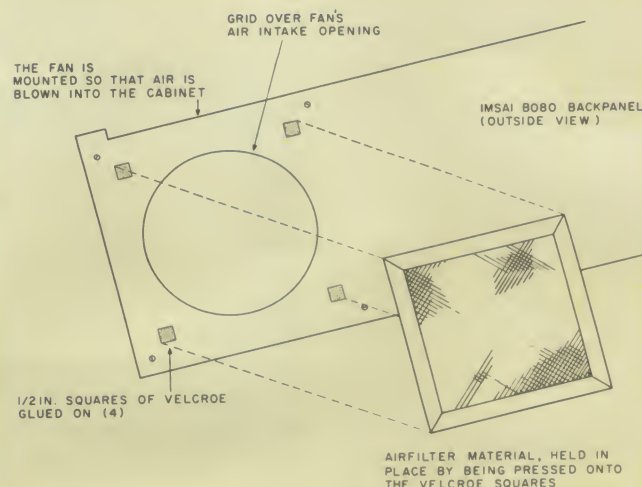


Fig. 4. Modification of fan mounting in the Imsai 8080.

look out, IMS Associates, here come mine.

Actually there are only three changes that I feel are needed. The first is to relocate the 7805 voltage regulators which are currently located below several ICs on the CP-A board, and below the system clock crystal and 8224 clock IC on the MPU board. The problem is that the PC boards are mounted vertically in the card cage, putting the ICs above the 7805 voltage regulator heat sinks and the heat generated by the 7805 voltage regulator. These ICs in my micro were running hot to the touch while others on the same board were running only slightly warm. While most ICs are capable of operating reliably at the higher temperatures, the probability of failure is also greater. The cure is to relocate the 7805 voltage regulator on the board so that it is not directly under any ICs or clock frequency determining components.

Relocating the five regulators would solve the heat problem on future Imsai 8080s. But what about systems currently in use? Moving the 7805 voltage regulator probably is not feasible. The solution I found was to modify the 7805 voltage regulator heat sink. The modification was simple (see Figs. 2 and 3), and the ICs are now much cooler.

The second change is to have the muffin fan mounted so that it blows air into the cabinet rather than out (see Fig. 4). With the fan blowing air into the cabinet, the power supply components and PC boards in the card cage are bathed with air more uniformly than if air were being sucked into the cabinet from the various openings in the chassis cover. You can check this out by mounting the fan so that air is pushed into the cabinet. Now move your hand along the air vents on the chassis cover. You should find the air flow to be more uniform. The other

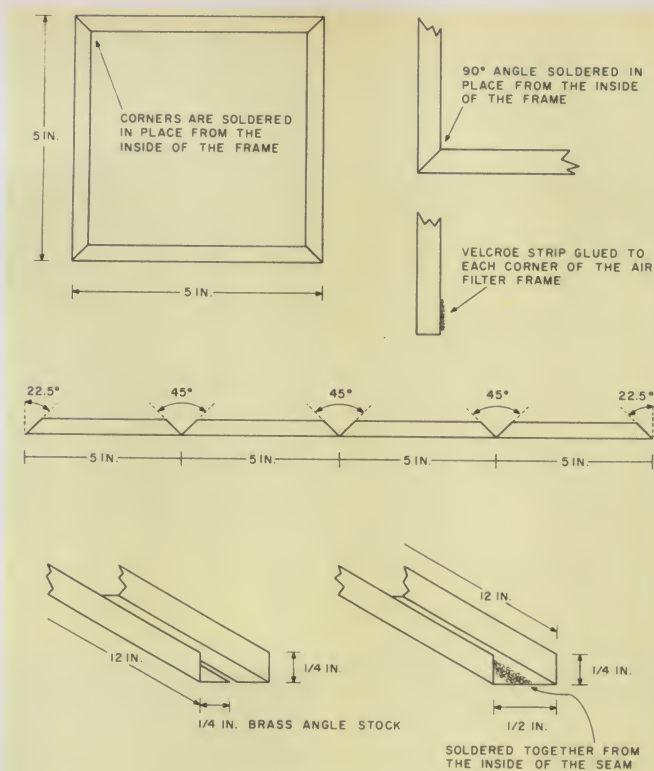


Fig. 5. Construction details of the air filter assembly.

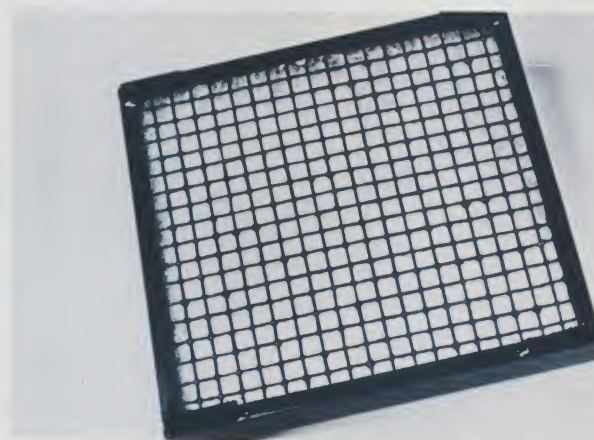


Photo 9. Air filter assembly.



Photo 10. Rear panel of Imsai 8080 chassis with the fan air filter assembly installed. Note use of press-on lettering to designate I/O connector use.

advantage is that the air going into the chassis can be filtered of dust and dirt (see Fig. 4) at the fan intake opening. Figs. 5 and 6 give details of a small air filter which can be built for a few dollars, does a reasonable job and can be cleaned with a vacuum cleaner.

The third change is a modification of the original chassis cover to make the system's insides more accessible as well as improve the Imsai 8080's appearance. My cover design (Figs. 7 and 8) is convenient in that only the top cover must be taken off to gain access to the PC cards, and can be left off, allowing continuous access to the card cage. There is less chance of a stray wire on the table or workbench falling into the system because the side panels of the original chassis cover are still in place.

The modification is started by drilling a 5/8 inch hole centered on the top of the chassis and one inch in from the edge. This hole allows cutting out to the edges with a sabre saw, and will later be a finger lift hole after the cover has been finished and installed. I next drilled three small holes on the top of the other end of the cover (again one inch in from the edge) and cut along this edge with the sabre saw. Three more small holes were drilled on each side of the cover about 1/8 inch from the top. Starting at these holes on the sides of the cover I cut along the sides from the first cut (made to the top of the cover) to the cut on the other end of the top. The sabre saw was then used to cut down the side from each cut on the top just enough to meet the cut made along the sides of the chassis cover. This method of cutting out the top access leaves a cover which will rest on the remaining sides and makes a better-looking finished product than if all the cuts had been made from the top.

Next, cut to length a piece of 1/8 inch thick by 3/4

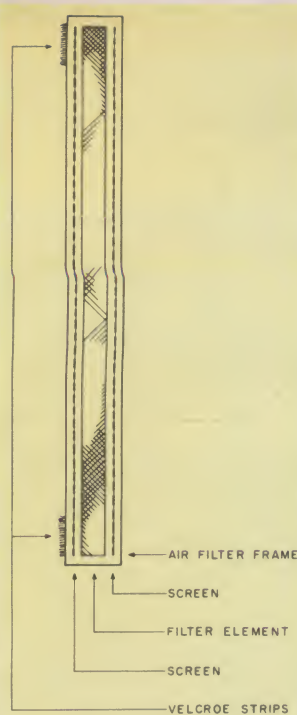


Fig. 6. Air filter assembly.

inches wide aluminum bar to form the lower part of the front bezel. This piece can be heliarced (a method of arc welding aluminum) to the rest of the chassis cover or attached by drilling two small-diameter holes through each end of the lower front bezel and up into the sides. Then spread a small amount of epoxy glue on each end of the bar and attach it to the lower front of the cover. Now insert two small brad nails through the holes in the bar and up into the cover. Cut off any excess brad and allow the epoxy to set.

When the epoxy has hardened, drill and countersink two more holes on each side of the cover. Be sure that these holes line up with the drilled and tapped holes near the top of the sides on the two end pieces of the chassis sheet metal. These holes will add mechanical stability when the modified cover is installed. Now drill four holes along the top of each side about $\frac{1}{2}$ inch in from the top. These will hold the $\frac{1}{2}$ inch aluminum angle stock (see Figs. 7 and 8) to which the top cover will be secured with flathead countersunk machine screws. Next cut the $\frac{1}{2}$

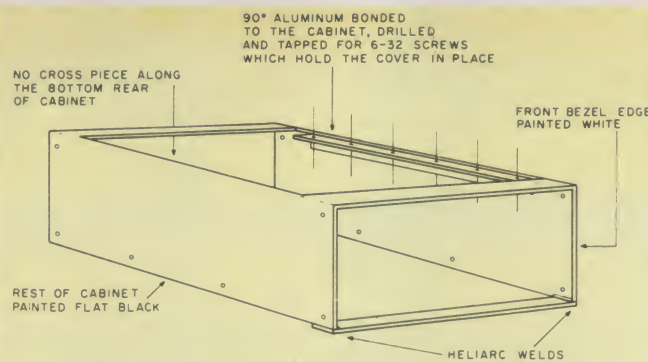


Fig. 7. Modified cabinet for the Imsai 8080.



Fig. 8. Modified cabinet cover details.

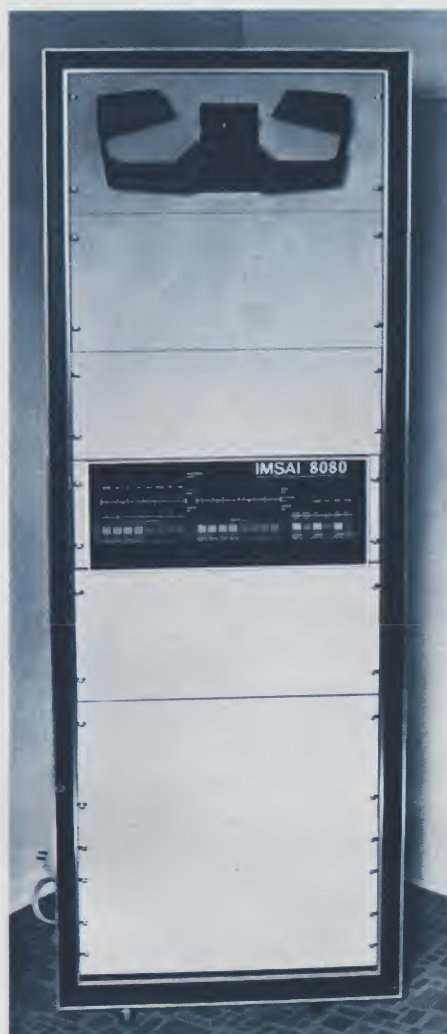


Photo 11. Finished Imsai 8080 microcomputer system with modified cabinet installed mounted in a rack enclosure with a paper tape reader (but with ample room for additional mass storage peripherals).

inch angle stock for each side of the cover and drill four holes in each piece, making sure that the holes line up with those in the sides of the cover. When the aluminum angle pieces have been bolted onto the sides, set the cover in place and drill four holes along each side of the cover, making sure that each hole goes through the center of the top of the angle stock. If you use a drill bit which is the pilot hole size for a tap, the resulting holes in the angle stock can be threaded with a hand tap. Now you can secure the access cover with machine screws. The holes in the access cover are drilled out and countersunk so that the machine screws will be flush with the surface of the cover.

Now that all the hardware work is done, file or sand any rough edges and lightly sand the whole cover so that new paint will adhere properly. The color scheme is up to you (after all, it is a personal computer isn't it?). I chose the flat black chassis cover with a white bezel edge because I felt that it fit well with the black background and white lettering used on the front panel. And of course the red and blue paddle switches add just the right amount of color. I am pleased with the way the system looks, and even knowing how much additional work would be involved, I would still go ahead and modify the chassis cover again.

Conclusions

Well here lies in print all that I had to do or wanted to do to my Imsai 8080. I have learned quite a bit about hardware and a little bit about the work involved in getting a computer system together and "up and running". For me the time, energy, and the money have been well spent. Looking back over the past eight months of work assembling and modifying my micro, I would still do it all again — it was interesting. ■

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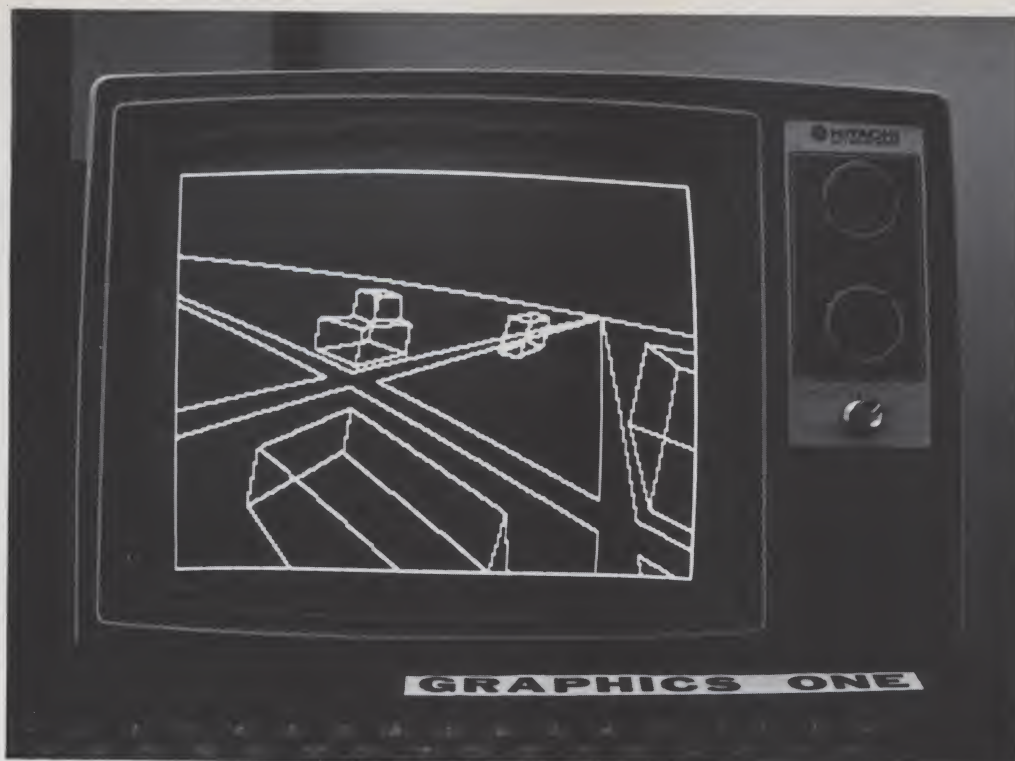


Fig. 1. A wide angle view of a few simple architectural forms. A 6800 microcomputer can produce this simple scene at a few frames per second if very efficient programming is used. The 200 x 200 bit map display can best be described as coarse.

3D Computer Graphics

... you don't need glasses !

Bruce A. Artwick
Sublogic
P.O. Box 3442
Culver City CA 90230

Graphics is an area that I'm sure most of us find exciting. When you consider some of the applications (games, educational programs, etc.) that we'll see sophisticated graphics, such as 3D, used for in the years to come it gets even more exciting! Bruce's article describes a package he and his associates have developed and are marketing through their company, Sublogic. Included in the article is a listing for a "starter program" which you can get running with minimum hardware and memory.
— John.

A highway engineer is casually driving down a road which doesn't exist, enjoying the scenery. Meanwhile, a pilot is in a spin, airspeed climbing, watching the runway which is coming up fast! It's three-dimensional, dynamic computer graphics which is making both simulations possible, and if similar types of computerized display systems were available to everyone, who knows how many interesting events would be occurring. Until this time, however, only a limited number of real-time 3D systems were available. The hardware involved was usually large, bipolar, fast, and very expensive, ranging from tens to hundreds of thousands of dollars. This is hardly what a hobbyist could afford. Dedicated 3D digital projection hardware is still prohibitively expensive, and such an investment is not desirable simply because it is dedicated to only one task.

Graphics display devices (raster scan bit maps), on the other hand, are a different matter. Prices are at an all time low, putting conventional although somewhat coarse 2D graphics within

reasonable economic reach. To enter the world of three dimensions, all that is needed is a low-priced graphics generator, and the microcomputer can quite successfully take on the role if applied properly.

Software is the key to making a microcomputer perform as an efficient 3D to 2D transformer. Having limited memory and running real-time demands efficiency, and although a high level language such as BASIC could be used, speed-wise the results would be disappointing. Optimized assembly language combined with good real-time programming techniques and double or triple precision arithmetic can increase speed on the order of ten to one hundred times.

The Sublogic Three-Dimensional Micrographics Package is a collection of such graphics programs which can be used in whole or on a subroutine basis for computerized 3D graphic simulations. Three-dimensional data bases may be observed in a dynamic mode from any position or angle in space. Versions of the graphics package are currently available in 6800 assembly language and in BASIC for slower graphics. This article will present some of the methods used in the graphics package and will provide insight into the problems faced by the graphics programmer. The micro or minicomputer user can take it from there in putting 3D graphics to use in his special application.

Graphics Quality

What quality of graphics can be expected from a microprocessor? Broadcast quality, speed and density are definitely not possible. Even the large machines have trouble here. Processing bandwidth is the limiting factor. An eight-bit machine with a two MHz clock simply cannot generate a six MHz bandwidth picture. It should be kept in mind that 3D to 2D conversion is not a trivial process either. The majority of the processor's time is spent doing mathematical calculations which cut down projection speeds drastically. Projection frame rates and image complexity are inversely proportional. If five minutes are allowed to generate one frame, an extremely dense image is attainable. A dynamic display of ten frames per second, on the other hand, will be relatively sparse. The software should be capable of making speed/complexity trade-offs at the user's discretion.

A 3D Graphics Algorithm

There's much more to 3D projection than meets the eye. There are the obvious tasks of data base transformation (which considers the viewer's position and viewing angle), and 3D to 2D perspective projection. Added to this is the necessary task of off-screen line elimination and clipping for objects which fall off or partially off the screen. There are also the optional tasks of hidden line elimination, shading, shadowing and reflection. For the 3D Micro-

Projection Method	3D to 2D wire frame transformations with clipping.
X, Y, Z Range	+ and - 32767 on X, Y and Z axes resulting in a 12.4 mile range with one foot resolution.
Viewing capabilities	Full 6 variable range. Viewer's position: + or - 32767 in X, Y, Z Viewer's angle: 360 degrees on pitch, bank and heading.
World size	1912 cubic miles (with one foot resolution) 2.8×10^{14} possible coordinates.
Special feature	Variable viewing angle. Range: 10 to 45 degrees from telephoto to wide angle.
Projection timing	4x4 matrix multiply (double precision) = 5 ms per point Clipping speed = 4 ms per line Projection = 1 ms per line
Future features	Array handling and frame synthesizing. Effectively 3 times the display rate.

Fig. 2. Characteristics of the Sublogic 3D Micrographics Program number 3DG68V3.

graphics Package, in the interest of reasonable speed and memory requirements, the simple wire frame line transformation, clipping and perspective projection method was chosen. Fig. 1 shows the type of image which a microcomputer can reasonably produce on a low-cost display system. Fig. 2 shows display characteristics and performance.

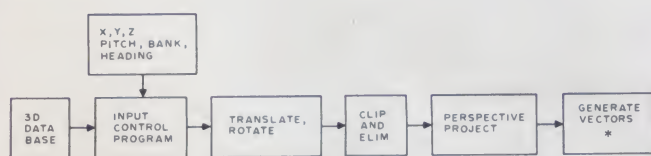
Modularity is important in graphics programming since many subtasks must be performed. Fig. 3 shows a good program partitioning.

Data Base Structure

The data base is essentially the world which is going to be projected, represented as a series of lines in a three coordinate space. Each line is

represented as a start point (X,Y,Z) and end point in memory. By properly transforming the two points, the line between them is also transformed. Since much time is needed to transform a point, a 2:1 time savings can be realized on large objects by using strings of lines or start and continue points. The lines (a to b) and (b to c) would be expressed as (a to b to c) resulting in three point transformations instead of four.

A number of methods for building data bases exist. One is to have a computer digitize a drawing or picture. Another is to have the user generate it with a joystick arrangement. For the data base sizes used by a microcomputer system, generation of a data base by



*Vector generation may have to be done by microcomputer as many display devices don't have vector capabilities.

Fig. 3. The major operational modules of the display program. Modular partitioning allows for future expansion and multiprocessing.

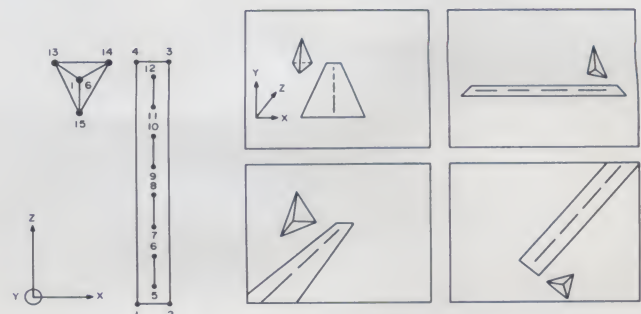


Fig. 4. A road and a pyramid. This simple data base will be used for illustrative purposes. Notice the coordinate numbering sequence and the X, Y and Z directions.

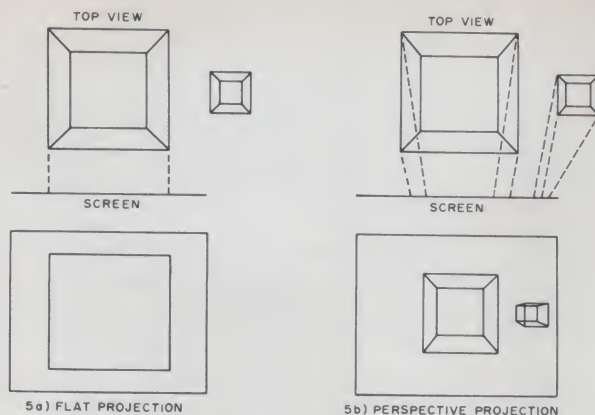


Fig. 5. A flat and a perspective projection of a cube onto a screen. The perspective projection pushes points in the distance toward the screen's center by dividing by the depth (Z).

hand with grid paper is probably the best choice. Fig. 4 shows a simple data base which shall be used in the examples henceforth. The sixteen points are numbered in the optimal order for stringing lines together with continue points.

Space/Screen Coordinate System

The 3D coordinate system is set up so the resulting 2D image displays X and Y on the screen in typical graph axis fashion with Z representing depth.

Perspective Projection

3D to 2D perspective projection is really an easy process. First, imagine a flat projection of a 3D scene on a 2D screen; that is, merely

eliminate the Z component and plot the lines on the screen. Fig. 5a shows a cube being transformed. The cube has indeed been projected, but there is no depth consideration. Whether the cube was a foot or a mile away the result would look the same. Optical geometry shows that lines appear to get shorter as the inverse of the distance. By plotting X/Z and Y/Z instead of just X and Y, points progressively further away will be pushed closer to zero which is the center of the screen (see Fig. 5b). Note that, in addition to perspective, the small cube is now visible. This is due to the viewer's cone (as opposed to tunnel) of vision. In the case of the rectangular screen this becomes the viewing

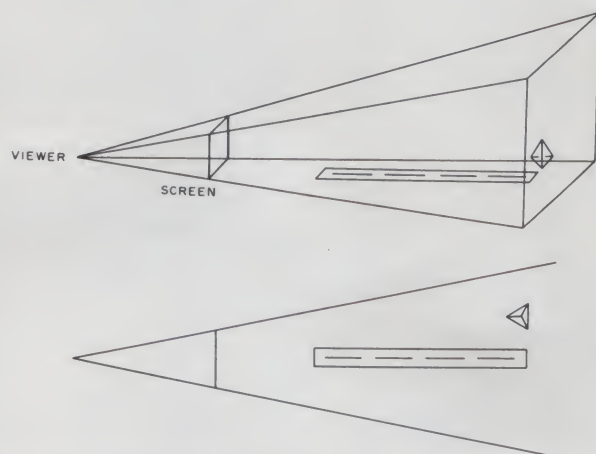
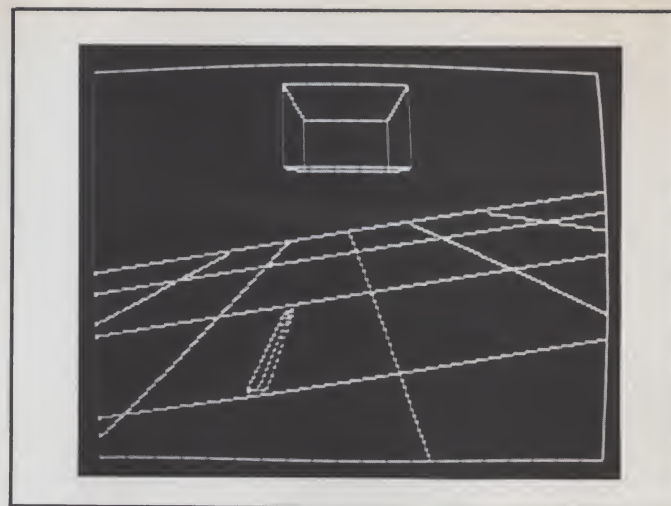


Fig. 6. The viewing pyramid encloses all objects which can be seen and thus displayed. In theory, the viewing pyramid angles change as one gets closer to the screen.



pyramid. This concept is used extensively in the program. Fig. 6 illustrates the viewing pyramid.

Line Clipping

Line clipping is the most difficult procedure in the display program. The following questions must be asked of each line in the data base: 1. Does the line belong on the screen or is it outside the viewing pyramid? 2. Does the line somehow intersect the viewing pyramid if one or both points are off the screen?

Using the line's end points, an equation for the line can be set up. Solved simultaneously with the equations for the planes of the pyramid, a line can essentially be pushed toward the pyramid's boundaries as shown in Fig. 7. It should be noted that 2D clipping (which some graphic terminals possess) will not work for 3D points due to the pyramid's increase in dimensions along the Z axis.

For exact equations and more information about the coding and clipping of lines, the Sublogic package or a text such as *Principles of Interactive Computer Graphics* by Newman and Sproull should be consulted.

Data Base Transformation

Data base transformation is what gives the viewer the amazing capability of being able to go anywhere and look at a scene from any direction or angle. Through a geometric transform, the world (3D data base) is first translated in the X, Y and Z directions by adding an offset to all data base points. The world is then rotated by multiplying by a heading, pitch and finally a bank equation. The four equations are most easily handled by the computer in matrix form, creating the need for a four by four transformation matrix derived from the offsets and rotation angles. Data base points are multiplied by the matrix in a

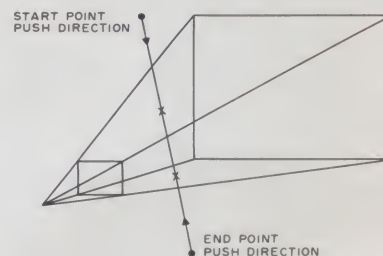
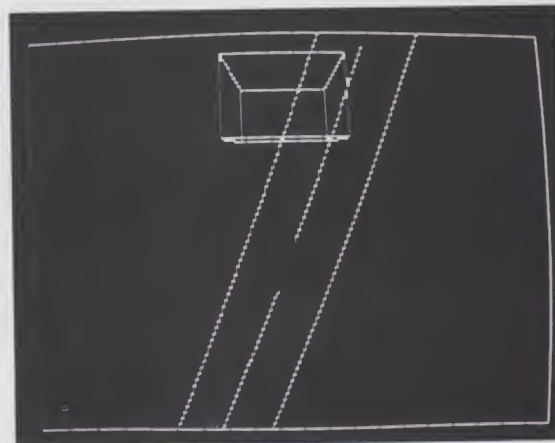
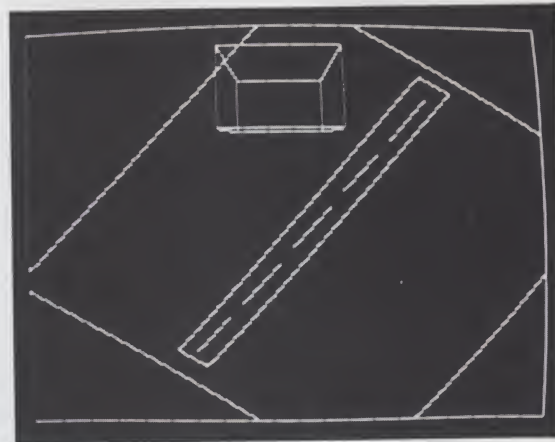
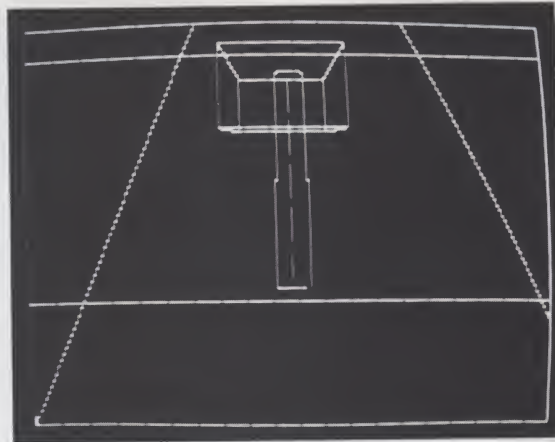
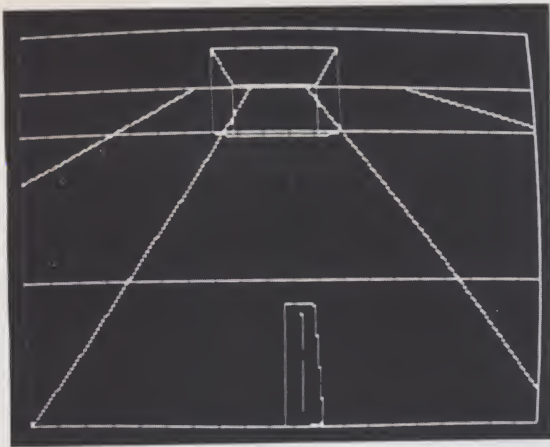


Fig. 7. Clipping. Only part of the line is visible (within the viewing pyramid). Before projection the lines must be clipped to meet the screen boundaries.



vector times matrix manner. Fig. 8 shows the data base being rotated. It is interesting to note that it is the world which moves, not the viewer. The matrix shown in Fig. 9 is the proper transform and need only be created once for each image. A separate sub-routine in the program is set aside to do this.

That's About It — Or Is It?

In principle that's about all there is to getting a 3D wire frame projection on the screen; transform, clip and project. Using a microcomputer to accomplish this, however, poses a number of interesting problems. For any serious graphics, double precision accuracy (on an eight-bit machine) is a must. High

speed double precision matrix multiplying, clipping and projection routines are needed. If the display device being used does not have vector drawing capabilities, the microcomputer must also take on this responsibility. Running off the end of the data base is another problem. If a point is near the end of the data base and the viewer moves a little too much in the wrong direction (remember, it's the world which actually moves), the point can "fall off the edge of the world" or integer overflow. Scaling, saturation, or a smaller data base can help here.

The projection of the integer world with its discrete point values can cause severe distortion with points close

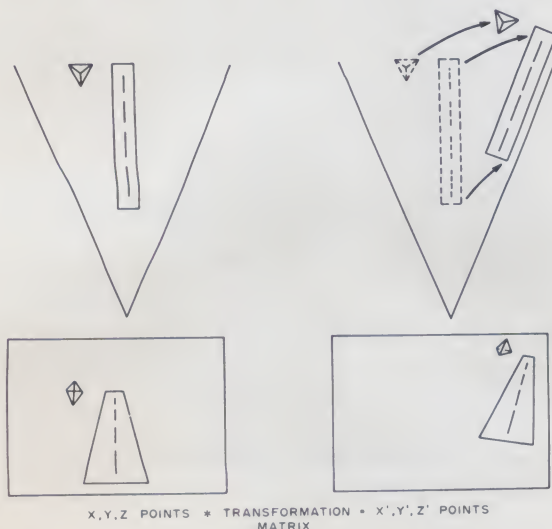


Fig. 8. Data base translation and rotation permits views from any direction or angle. Notice that it is the world that moves.

to the viewer. At one integer unit from the screen, for example, a point within the viewing pyramid can only be in one of nine positions ($X=-1,0,1$ and $Y=-1,0,1$) which makes for some pretty rough movements of near lines. The Sublogic package uses a spherical compression method to reduce this problem. Programming considera-

tion should also be given to "running into points." If a point falls at the base of the viewing pyramid ($z=0$), a divide by zero will result upon projection.

Conclusion

Getting 3D graphics and dynamic 3D graphics up on a microcomputer system requires at least 8K of memory

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ DX & DY & DZ & 1 \end{bmatrix} \begin{bmatrix} a & b & c & 0 \\ d & e & f & 0 \\ g & h & i & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \text{TRANSFORMATION MATRIX}$$

$$\begin{aligned} a &= \cos H \cos B + \sin H \sin P \sin B \\ b &= -\cos H \sin B + \sin H \sin P \cos B \\ c &= \sin H \cos P \end{aligned}$$

$$\begin{aligned} d &= \cos P \sin B \\ e &= \cos P \cos B \\ f &= -\sin P \end{aligned}$$

$$\begin{aligned} g &= -\sin H \cos B + \cos H \sin P \sin B \\ h &= \sin H \sin B + \cos H \sin P \\ i &= \cos H \cos P \end{aligned}$$

Where P = Pitch, B = Bank and H = Heading.
DX, DY, and DZ = X, Y, and Z translation respectively.

Fig. 9. The translation matrix (left) is multiplied by the rotation matrix yielding the transformation matrix. Fortunately, this matrix need only be computed once per frame.

for a 6800 or 6500 series processor, and possibly more for an 8080-based system. Dynamic graphics, in addition, requires some sort of screen erase or update feature to remove the old display frame before the new one appears. Individually erasing vectors can cause image degradation due to line intersection erasures.

As for microcomputer preference, any one will do, with speed and memory size being the main difference in the final result. The 6800

systems work extremely well due to the large quantity of mathematics being performed in a real-time mode. Incidentally, the Sublogic package in assembly language form was first developed on a Southwest Technical Products 6800 System.

For those interested in multiprocessors, graphics is a great application as the algorithm partitions very nicely. A 6800 processor can do all the complex transforms, for example, and an 8080 system can generate

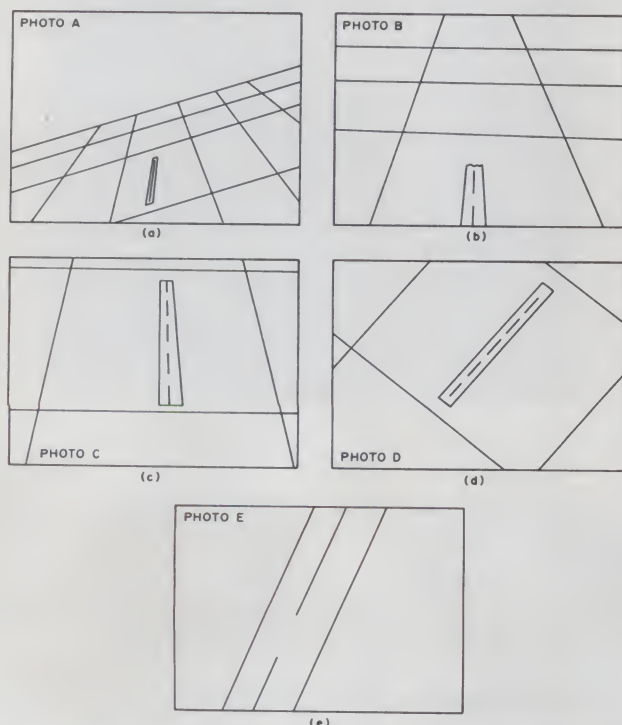


Fig. 10. Crashing through a runway can be quite safe with 3D graphics. The cube is in the aircraft's reference frame and remains the same in all frames.

vectors and control the screen display. The images shown in Figs. 1 and 10 were, in fact, generated using a SWTP 6800 for the 3D routines and a Graphics One 200 x 200 dot matrix intelligent graphics terminal for vector generation.

A 3D display program can, of course, be written completely by the user, or a whole display program can be purchased from Sublogic. A few books exist on the subject, but floating point algorithms are usually given. For speed's sake a good text on integer programming should be consulted (this is also hard to find).

Three-dimensional micro-computer graphics is now available to all microcomputer users. Real-time simulations, games, modeling and art are now possible. This is just a subset of the total list, however, which is indeed limitless.

A 3D Graphics Program For Experimentation and Familiarization

A somewhat condensed version of the BASIC Sublogic 3D Micrographics program is flowcharted in Fig. 11, and a listing is provided (Program A). With this program, anyone with a CPU, 4K BASIC and a console terminal can get started with 3D graphics.

Extensive rotation capability has been omitted to limit program size and memory requirements, but two

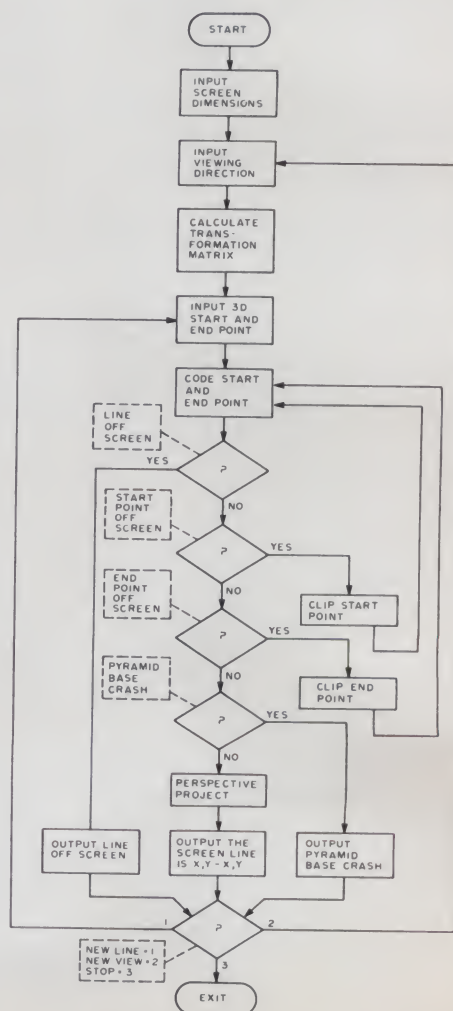


Fig. 11. Flowchart for 3DGKB.V01.

viewing angles (front and rear) have been provided in lieu of rotation. Users with about 17K of memory can use a BASIC interpreter with trig functions to generate the complete matrix (see Fig. 9 and listing block 8400).

This program is very modular and permits easy interfacing to any user's system. The input and output handlers simply ask the user for input parameters (3D start and end points of lines and the viewer's 3D position) and writes the resulting 2D output display point values on the console terminal. This simple I/O protocol allows the user to first get the program up and tested without a graphics display device. The user can then substitute his own I/O handlers (blocks 8100 and 8300) to load display files (arrays of many lines), format the output, and send it to his Polymorphics, Dazzler, SWTP or Matrox display (to name just a few). The USER, POKE and PEEK functions available with most BASICs will be quite useful here.

Fig. 12 shows a sample run. All input parameters are floating point. Although a viewer's angle of 1.0 is said to be normal, .6 or .7 looks much more natural.

A unique line generator is

```
#
#RUN
SCREEN WIDTH? (W)
? 200
FIELD OF VIEW? (V)
? 1.0
VIEWER'S LOCATION? (X,Y,Z)
? 10,20,30
VIEWER'S ANGLE? (P,B,H)
? 0,0,0
FRONT VIEW=1, REAR VIEW=2
? 1
START PT. COORDINATE? (X,Y,Z)
? 0,0,500
END PT. COORDINATE? (X,Y,Z)
? 20,20,606
THE SCREEN LINE IS:
-2.12765957, -4.25531914 TO 1.73611111, 0
PIXEL= -2 -4
PIXEL= -1 -4
PIXEL= -1 -3
PIXEL= 0 -3
PIXEL= 0 -2
PIXEL= 1 -2
PIXEL= 1 -1
PIXEL= 2 -1
PIXEL= 2 0
NEW LINE=1, NEW VIEW=2, STOP=3
? 1
START PT. COORDINATE? (X,Y,Z)
? 27.9,56.8,-300
END PT. COORDINATE? (X,Y,Z)
? 10,-125,60
THE LINE IS OFF THE SCREEN
NEW LINE=1, NEW VIEW=2, STOP=3
? 3

READY
#
```

the bit width of your display device.
.5= telephoto, 1=normal
1.5=wide angle
where you are in space

what viewing direction?
pitch, bank, heading
remember, true rotation
isn't used in this version.
submit the line coordinates.

pixel listing can be omitted by changing line 8345.

Fig. 12. A sample run of 3DGKB.V01.

included in the 8900 block. Only twenty-one statements are required to generate all the points on a line. No trig functions, multiplications or divisions are needed. The Graphics One photographs of Figs. 1 and 10 were generated

using an assembly language version of this routine.

Complete Three-Dimensional Micrographics Packages in BASIC for slow graphics and 6800 assembly language for high speed applications are available from Sublogic,

PO Box 3442, Culver City CA 90230, for \$22 and \$28 respectively. Both packages include valuable interface and applications information. The 2900 line 6800 version includes a Kansas City standard tape for easy entry. ■

Program A. 3DGKB.V01 Listings (continued on following page).

```
8000 REM 3D GRAPHICS VERSION 3DGKB.V01 5/27/77
8002 REM AUTHOR- B. ARTWICK FOR SUBLOGIC CO.
8004 REM PROGRAM USE- SLOW SPEED 3D GRAPHICS FOR
8006 REM EXPERIMENTATION AND FAMILIARIZATION.
8008 REM LANGUAGE- MINIMAL SET BASIC (SWTP 4K TYPE)
8010 REM MEMORY REQUIRED- 11K INCLUDING 4K FOR BASIC.
8012 REM FEATURES- PERSPECTIVE PROJECTION, CLIPPING,
8014 REM VARIABLE VIEWING WINDOW, LINE GENERATOR,
8016 REM COORDINATE TRANSLATION.
8018 REM OPTIONS AVAILABLE FROM SUBLOGIC- OPTIMIZED
8020 REM CLIPPING, COORDINATE ROTATION, ARRAY
8022 REM HANDLING, 6800 ASSEMBLY VERSIONS FOR
8024 REM SERIOUS DYNAMIC APPLICATIONS.
8026 REM EQUIPMENT NEEDED- A CPU AND CONSOLE TERMINAL
8028 REM ARE ENOUGH TO GET STARTED. A GRAPHICS
8030 REM DISPLAY DEVICE IS HIGHLY DESIRABLE.
8034 REM VARIABLE DEFINITION -----
8036 REM X,Y,Z ARRAYS 1 THROUGH 5 ARE FOR:
8038 REM 1= 3D START PT. 2= 2D START PT. (NO Z)
8040 REM 3= VIEWER'S TRANSLATIONAL POSITION
8042 REM 4= 2D END PT. 5= 3D END PT.
8044 REM C= CLIPPING CODE ARRAY
8046 REM T= TRANSFORMATION MATRIX ARRAY
8048 REM P,B AND H= PITCH,BANK AND HEADING
8050 REM P2= PROJECTION FLAG
8052 REM W,V= WINDOW AND FIELD OF VIEW
8053 REM A,B,D,E,G,H,M,N,S= TEMPORARY STORAGE
8054 DIM X(5),Y(5),Z(5),C(8),T(16)
```

```
8100 REM INPUT HANDLER -----
8105 REM ALL VARIABLES NEEDED TO TRANSFORM, CLIP
8110 REM AND PROJECT ONE LINE ARE ASKED FOR.
8120 PRINT "SCREEN WIDTH? (W)"
8125 INPUT W
8126 W=W/2
8130 PRINT "FIELD OF VIEW? (V)"
8135 INPUT V
8140 PRINT "VIEWER'S LOCATION? (X,Y,Z)"
8145 INPUT X(3),Y(3),Z(3)
8150 PRINT "VIEWER'S ANGLE? (P,B,H)"
8155 INPUT P,B,H
8160 REM CREATE THE TRANSFORMATION MATRIX
8165 GOSUB 8442
8170 PRINT "START PT. COORDINATE? (X,Y,Z)"
8175 INPUT X(1),Y(1),Z(1)
8180 PRINT "END PT. COORDINATE? (X,Y,Z)"
8185 INPUT X(5),Y(5),Z(5)
8200 REM EXECUTION CONTROL -----
8203 REM A LINE IN 3D SPACE IS TRANSFORMED TO
8206 REM A 2D SCREEN LINE. THE INPUT HANDLER HAS
8209 REM ALREADY BUILT THE TRANSFORMATION MATRIX
8218 REM PERFORM TRANSLATION, ROTATION AND
8219 REM VIEWING WINDOW CALCULATIONS
8221 GOSUB 8530
8224 REM CLIP THE LINE
8227 GOSUB 8608
8230 REM PROJECT THE LINE
```



```

8233 GOSUB 8830
8236 REM DISPLAY THE RESULTS
8239 GOSUB 8330
8242 REM ASK FOR ANOTHER LOOP, NEW VIEW OR STOP
8245 PRINT "NEW LINE=1, NEW VIEW=2, STOP=3"
8248 INPUT A
8257 ON A GOTO 8170,8140,8260
8260 END
8300 REM OUTPUT HANDLER -----
8305 REM THE SCREEN COORDINATES OR "LINE OFF
8310 REM THE SCREEN" MESSAGE IS PRINTED.
8315 REM THE USER CAN REPLACE STATEMENT 8345 WITH
8320 REM "RETURN" IF PIXELS ARE NOT NEEDED
8330 IF P2=0 THEN GOTO 8355
8335 PRINT "THE SCREEN LINE IS:"
8340 PRINT X(2);",",Y(2);" TO ";X(4);",",Y(4)
8345 GOSUB 8909
8350 RETURN
8355 PRINT "THE LINE IS OFF THE SCREEN"
8360 RETURN
8400 REM TRANSFORMATION MATRIX GENERATOR-----
8403 REM NORMALLY THE FULL TRANSFORMATION MATRIX
8406 REM WOULD BE CREATED. TO SAVE MEMORY, ONLY
8409 REM TWO VIEWS ARE POSSIBLE WITH THIS VERSION:
8412 REM FRONT AND REAR VIEWS.
8414 REM BASIC MUST INITIALIZE T MATRIX TO ZERO.
8442 PRINT "FRONT VIEW=1, REAR VIEW=2"
8445 INPUT A
8448 IF A=2 THEN GOTO 8480
8451 REM FRONT VIEW MATRIX
8454 T(1)=1
8457 T(6)=1
8460 T(11)=V
8463 T(13)=-X(3)
8466 T(14)=-Y(3)
8469 T(15)=-Z(3)*V
8472 T(16)=1
8475 RETURN
8478 REM REAR VIEW MATRIX
8480 T(1)=-1
8482 T(6)=1
8484 T(11)=-V
8486 T(13)=X(3)
8488 T(14)=-Y(3)
8490 T(15)=Z(3)*V
8492 T(16)=1
8494 RETURN
8500 REM MATRIX MULTIPLIER-----
8505 REM THE TWO INPUT VECTORS (START AND END
8510 REM POINTS) ARE MULTIPLIED BY THE
8515 REM TRANSFORMATION MATRIX "T".
8520 REM [X,Y,Z,1]      T1   T2   T3   T4   [X',Y',Z',1]
8521 REM .               T5   T6   T7   T8
8522 REM .               T9   T10  T11  T12
8523 REM .               T13  T14  T15  T16
8530 FOR A=1 TO 5 STEP 4
8535 G=X(A)
8540 H=Y(A)
8545 X(A)=G*T(1)+H*T(5)+Z(A)*T(9)+T(13)
8550 Y(A)=G*T(2)+H*T(6)+Z(A)*T(10)+T(14)
8555 Z(A)=G*T(3)+H*T(7)+Z(A)*T(11)+T(15)
8560 NEXT A
8565 RETURN
8600 REM LINE CLIPPER -----
8601 REM LINES ARE CODED WITH RELATION TO THE
8602 REM VIEWING PYRAMID AND CLIPPED IF
8603 REM NEEDED. THE PROJECTION CODE IS SET.
8606 REM CODE THE START AND END POINT.
8608 FOR A=1 TO 5 STEP 4
8610 C(A)=0
8612 C(A+1)=0
8614 C(A+2)=0
8616 C(A+3)=0
8618 IF X(A) < -Z(A) THEN C(A)=1
8620 IF X(A) > Z(A) THEN C(A+1)=1
8622 IF Y(A) < -Z(A) THEN C(A+2)=1
8624 IF Y(A) > Z(A) THEN C(A+3)=1
8626 NEXT A
8630 REM OFF SCREEN LINE CHECKING
8632 FOR A=1 TO 4 STEP 1
8634 IF C(A)=0 THEN GO TO 8638
8636 IF C(A)=C(A+4) THEN GOTO 8668
8638 NEXT A
8642 REM START POINT OFF SCREEN CHECKING
8644 FOR A=1 TO 4 STEP 1
8646 IF C(A)=1 THEN GOTO 8676
8648 NEXT A
8652 REM END POINT OFF SCREEN CHECKING
8654 FOR A=5 TO 8 STEP 1
8656 IF C(A)=1 THEN GOTO 8686
8658 NEXT A
8660 REM THE LINE IS ON THE SCREEN. SET P2.
8662 P2=1
8664 RETURN
8666 REM THE LINE IS OFF THE SCREEN. RESET P2.
8668 P2=0
8670 RETURN
8674 REM CLIP THE START POINT
8676 A=1
8678 B=5
8680 GOTO 8694
8684 REM CLIP THE END POINT
8686 A=5
8688 B=1
8692 REM CLIP. PUSH POINT XYZ A TOWARD XYZ B.
8694 IF C(A)=1 THEN GOTO 8728
8696 IF C(A+1)=1 THEN GOTO 8714
8698 IF C(A+2)=1 THEN GOTO 8742
8700 IF C(A+3)=1 THEN GOTO 8756
8704 REM THE LINE IS ON THE SCREEN.
8706 GOTO 8662
8712 REM PUSH XYZ A LEFT
8714 K=(Z(A)-X(A))/(X(B)-X(A)-Z(B)+Z(A))
8716 X(A)=K*(Z(B)-Z(A))+Z(A)
8718 Y(A)=K*(Y(B)-Y(A))+Y(A)
8720 Z(A)=X(A)
8722 GOTO 8608
8724 REM
8726 REM PUSH XYZ A RIGHT
8728 K=(Z(A)+X(A))/(X(A)-X(B)-Z(B)+Z(A))
8730 X(A)=K*(Z(A)-Z(B))-Z(A)
8732 Y(A)=K*(Y(B)-Y(A))+Y(A)
8734 Z(A)=-X(A)
8736 GOTO 8608
8740 REM PUSH XYZ A UP
8742 K=(Z(A)+Y(A))/(Y(A)-Y(B)-Z(B)+Z(A))
8744 X(A)=K*(X(B)-X(A))+X(A)
8746 Y(A)=K*(Z(A)-Z(B))-Z(A)
8748 Z(A)=-Y(A)
8750 GOTO 8608
8754 REM PUSH XYZ A DOWN
8756 K=(Z(A)-Y(A))/(Y(B)-Y(A)-Z(B)+Z(A))
8758 X(A)=K*(X(B)-X(A))+X(A)
8760 Y(A)=K*(Z(B)-Z(A))+Z(A)
8762 Z(A)=Y(A)
8764 GOTO 8608
8800 REM PERSPECTIVE PROJECTION -----
8805 REM THE LINE IS NOT PROJECTED IF P2=0
8810 REM IF P2=1 THE LINE IS CHECKED FOR A
8815 REM PYRAMID BASE CRASH (X=Y=Z=0)
8820 REM AND IS THEN PROJECTED
8830 IF P2=0 THEN RETURN
8840 IF Z(1)=0 THEN GOTO 8890
8845 IF Z(5)=0 THEN GOTO 8890
8855 X(2)=X(1)/Z(1)*W
8860 Y(2)=Y(1)/Z(1)*W
8865 X(4)=X(5)/Z(5)*W
8870 Y(4)=Y(5)/Z(5)*W
8875 RETURN
8890 PRINT "LINE CRASHED AT PYRAMID'S BASE"
8893 PRINT X(1);Y(1);Z(1);",",X(5);Y(5);Z(5)
8895 P2=0
8896 RETURN
8900 REM LINE GENERATOR-----
8903 REM A SUM TRACKING ALGORITHM IS USED TO
8906 REM GENERATE ALL PIXELS BETWEEN 2 LINES.
8909 X(2)=INT (X(2)+.5)
8912 Y(2)=INT (Y(2)+.5)
8915 X(4)=INT (X(4)+.5)
8918 Y(4)=INT (Y(4)+.5)
8921 S=0
8924 M=1
8927 N=1
8930 D=X(4)-X(2)
8933 IF D < 0 THEN M=-1
8936 IF D < 0 THEN D=-D
8939 IF D=0 THEN S=-1
8942 E=Y(4)-Y(2)
8945 IF E < 0 THEN N=-1
8948 IF E < 0 THEN E=-E
8951 PRINT "PIXEL=";X(2);Y(2)
8954 IF X(2)=X(4) THEN GOTO 8978
8957 IF S < 0 THEN GOTO 8969
8960 X(2)=X(2)+M
8963 S=S-E
8966 GOTO 8951
8969 Y(2)=Y(2)+N
8972 S=S+D
8975 GOTO 8951
8978 IF Y(2)=Y(4) THEN RETURN
8981 GOTO 8957
8990 REM PROGRAM END -----

```




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Processor Technology

Memory Troubleshooting Techniques

... take a bit for a walk

This is one of the best articles on memory troubleshooting I've seen in a long time. Charles has derived the material presented here from his experiences with large mainframe machines and the 24-bit home brew computer he built (which is why you won't find any listings for the test program he wrote ... but the flowcharts are fine). — John.

Everyone who owns his own computer and has to perform his own maintenance eventually asks the question, "Gee, wouldn't it be nice if this thing were really intelligent and could tell me when it is ailing and exactly where the trouble is?" This is especially true of the kit-builder, since it is in the early stages of his computer's life that a marginal solder joint or faulty IC begins to cause problems.

Of course, Murphy's law dictates that it will usually be an intermittent problem occurring perhaps one time in several thousand clock cycles. Try to single step your computer and find that! Once again Mr. Murphy is going to hide the trouble until you think the gremlin has gone away. So you confidently put the thing back in service, and sure enough, the trouble pops up again.

Perhaps we really do have

just as many easy-to-solve, nonintermittent problems, but since they are easy to find they don't seem as troublesome and, therefore, don't loom as large in the troubleshooter's mind. Occasionally some of the permanent-type problems can be real mindbenders too.

Everyone complains about the shortage of software (lately the situation has become much better), but I have heard few complaints about the scarcity of diagnostic software for detecting trouble in the memory or processor. I think it would be a step in the right direction if the manufacturers of microcomputers would supply such diagnostic software in complete and exhaustive form. Since many don't (or at least don't advertise it extensively), I am going to present a few ideas here for checking out the memory.

An interesting analogy

would be the ailing physician who is able to diagnose his own problems — if he hasn't died from them yet. Likewise, our computer has a good chance of detecting its own problems as long as they are not too severe. Obviously, if its plug is pulled or a fuse is blown, it can't tell us any-

thing, and the operator would have to rely on his own senses to diagnose the trouble. Hardware bugs discussed in this article are of the less severe type and are associated primarily with the memory.

The Walking Bit

In the February, 1977, issue of *Kilobaud* magazine there is an excellent article by John Molnar on how to use the computer to diagnose its own memory ills. Briefly, part of that method is reviewed in Fig. 1 where we notice the most important feature, the walking bit.

Initially, a 1 is inserted in the least significant bit position (00000001), and this byte of memory is compared with the same byte in the processor. If the comparison shows them to be alike, then this portion of the memory test has been passed, and the next step of the test is executed. The next step would be to shift the accumulator contents (00000001) over one place to the left and then attempt to store this in the byte being tested. Once again a comparison is made to

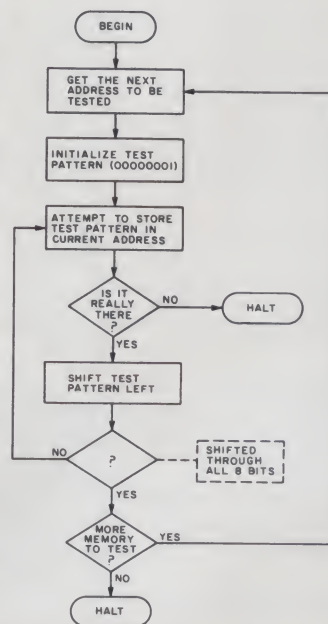


Fig. 1. Flowchart for the "walking bit" diagnostic routine.

see if this quantity (00000010) was really stored there.

In this same manner, proceed walking the 1 through until it gets to the most significant bit position. If all tests were passed, move on to the next memory address and test it in the same manner. This continues until we have been through all memory locations. Of course, if a test is failed, the computer will halt, and the operator could tell by where it halted and by the contents of various registers exactly where the faulty bit is. This is the basic idea of the walking bit test; however, there are some shortcomings that should be pointed out.

If the trouble is not in the memory but in the processor, the simple walking bit method won't detect it. If the machine did happen to stop on one of the halt commands of the walking bit program, it might not be clear to the operator whether the trouble was in the processor or in the memory.

Some other subtle effects not detected by the walking bit program occur when some memory address lines are shorted or open. The effect of this would be to actually have one memory location pointed to by two different addresses. A similar problem also occurs when memory input data lines are either shorted or open. These kinds of problems but occasionally might be caused by a bad IC. Printed circuit (PC) defects can be and often are intermittent. What is the probability that after testing each bit at each address just once, as in the walking bit method, we would detect the intermittent error? In some instances the probability would be very low.

Finally, how do we check out that part of the memory in which the diagnostic program itself is stored? After all, if that part of memory is bad, the diagnostic program wouldn't be executed properly. Problems of this

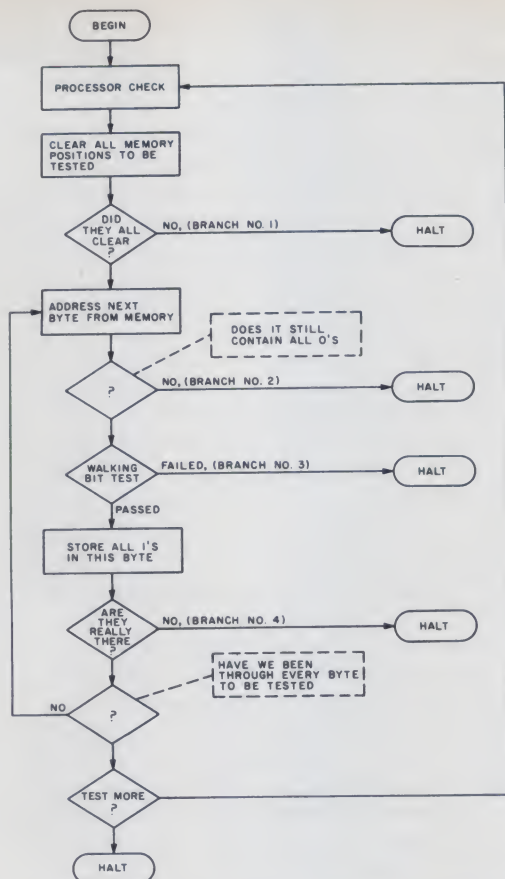


Fig. 2. Improved "walking bit" flowchart. Various faults of memory are detected and interpreted according to the branch on which the program stops. Branch #1 indicates that it is not possible to write all 0s in the byte being tested. Branch #2 indicates that when we addressed some other byte for writing into it, we actually wrote into the byte being tested. This could be due to defective (open or shorted) address lines. Branch #3 indicates that the byte being tested cannot have a 1 stored in some position and 0s elsewhere. A possible cause of this could be some shorted or open input data lines. Branch #4 will detect any bytes that are incapable of having all 1s stored in them.

type could conceivably be difficult to distinguish from processor faults.

Some of these shortcomings can be partially or completely overcome by a modified walking bit program. A flowchart of such a program is shown in Fig. 2.

Processor Bugs

While the leading block of Fig. 2 gives no specific details, it indicates a check of the processor independent of the main memory (RAM) other than that required to store the program. (An alternative to RAM storage would be to have the diagnostic program stored in PROM.) The way in which this block is implemented would be highly dependent upon the

type of processor used. Normally, such a check would include these commands not involving data transfers to or from the main memory, and even this type of instruction could be checked if there is a section of memory known to be good. This part of our program could be quite lengthy if we want to test all possible instructions with various patterns of data. To detect intermittent problems, it would also be desirable to test repetitively.

Writing a diagnostic program that has all these features and the ability to work around suspected areas of bad memory could be quite a chore. As an alternative, why not have a spare processor chip ready to plug

in if you suspect yours is on the fritz? After all, if the spare is bad too, chances are it won't exhibit the same faults as the original, so the operator wouldn't be misled. The cost of having an extra chip on hand shouldn't be too objectionable since that cost is almost negligible compared to the total cost of a typical system. Needless to say, this method applies only if the processor chip uses a socket instead of being soldered in place.

Replacing modules or integrated circuits in this manner is a good way to troubleshoot if you have the spare parts. Since memory boards are so expensive, it's not likely that spare would be lying around, and replacing individual memory ICs wouldn't be practical either since there are so many of them and some might even be soldered in place. It is also worth mentioning that the IC replacement method of troubleshooting fails if the trouble was a bad solder joint or a defective PC board.

Implementing the leading block of Fig. 2 is, therefore, left to the reader since it is so dependent on the particular system in use. It might even be desirable to omit this processor check altogether unless there is some specific reason for suspecting a problem. If any processor check is done at all, then it could be minimized by investigating only those commands to be used later in the memory check.

Shorted Or Open Lines

If some of the address lines to the memory are either shorted or open, then the actual byte addressed is not what the processor intends to address. Consider Fig. 3 in which the processor is trying to address location 17 (binary 0 ... 010001). Because of the open line on A3, that line will be interpreted as a logic 1 by the memory, and as a result, location 25 (binary 0 ... 011001) is addressed there.

This is because most floating inputs will act as if they are at logic 1. (It is poor design procedure to purposely let an input float even though it would probably behave itself and stay at logic 1.)

The break in the A₃ line of Fig. 3 is accidental and could have been caused by a variety of things. Possible causes include a hairline crack in a conductor on the PC board, a bad edge connector, a second-rate IC socket that isn't making proper contact with the IC pins, or perhaps a bad solder joint.

Speaking of poor solder joints, a certain supplier of printed circuit materials sells an immersion tin-plating system that will result in terrible solder connections if not soldered within two or three days after the tin is deposited. I have personally seen such solder connections that looked good but actually had several thousand Ohms of resistance. So be warned that this is a good way to assign yourself some extra debugging time if you make your own computer PC boards. Another way to get bad solder joints is just to use poor soldering techniques.

On the subject of second-rate IC sockets, I have had problems with the connector strip type. This is the type that is all metal and comes in a strip of around 75 to 100 pins. All pins initially have a common connecting tab running the entire length of the strip. For a 14-pin IC, two strips of 7 each are cut off and used for a socket. Out of a 60 IC computer system using these connector strips, I have seen 3 pins that didn't make contact. I have since resolved never to use these.

So much for the possible causes of the break in the A₃ line in Fig. 3 — it has already been shown as a result of the break that when we try to address location 17, we actually address location 25. What happens when we try to purposely address location 25? If when addressing location 25 we decide to write into it,

then we will be destroying whatever we thought we were writing into 17 earlier. Trying to read the contents of 17 later will result in location 25 being read.

A related problem occurs when two or more address lines are accidentally shorted together. However, for the sake of diversity, we will look at what happens when two input data lines, rather than address lines, are shorted. (A similar situation exists when output data lines are shorted.) Fig. 4 shows such a situation.

Note that data lines D₁ and D₂ are shorted together and that the processor is unsuccessfully trying to send binary 11101100 to the memory for storage there. The processor is attempting to send 0 for D₁ and 1 for D₂. The short forces them to be the same. Are they both a logic 1 or a logic 0? They will probably both be a 0, but what they actually are depends on the internal arrangement of the processor chip or buffers. The point is that both data lines will assume the same state because of the short, and the actual value transmitted to the memory is different from the intended value. The actual value received by the memory in this example is shown in Fig. 4 to be 11101000.

The problem of shorts is more serious than the problem of open circuits discussed earlier. True, they both cause errors, but shorted output lines can actually ruin an IC in some instances. Luckily, open connections are probably the more common of the two problems (neglecting solder bridges during construction).

Now that we know some effects of shorted and open lines associated with memory, how does the improved walking bit program of Fig. 2 detect them? If input data lines are shorted or open, the 1 will not walk through properly, and the program will halt on branch 3.

In the event of open or shorted address lines, each address that the processor points to actually corresponds to a pair of memory locations as discussed earlier. At some point in the program, one of the members of the pair is addressed and has all 1s written into it after passing the simple walking bit test.

Later in the program, the second member of the pair is addressed (but the same actual location) and will cause a halt on branch 2 since it has all 1s stored in it. An important feature here is that all memory locations were initially cleared and verified. Thus, if a halt on branch 2 is encountered, it is due to address problems and not because the byte originally contained some random number after power was turned on or because the byte failed to clear properly earlier in the program.

Repetitive Testing

Intermittent problems aren't all caused by shorts or opens. They can just as easily be caused by some IC with a weird defect or an IC with the not so weird defect of failing to operate within its assigned noise margin. (As an example of noise margin, consider the TTL logic family in which the noise margin is .4 V since the highest permitted voltage for a logic 0 is .4 V, and the lowest permitted voltage for a logic 1 is .8 V.)

Regardless of the cause of the intermittent problem, it is

possible to go through the entire testing procedure without finding it. The "Test More?" block of Fig. 2 helps avoid this problem by continuing to loop back through the test as many times as desired. Given enough time and patience, the program can continue to run until even the most stubborn intermittent problem has to surface for air.

Checking the Memory Containing the Program

Earlier it was mentioned that memory problems might occur in that portion of memory in which the diagnostic program itself is stored. The effect of such problems would be an improperly executed program, but the results could be so subtle as to be misleading to the operator. If trouble in this portion of the memory is suspected, the diagnostic program could be moved to an entirely different section of the memory, and it could be noted if the same trouble occurs there. ("Trouble" here is used in the sense that halts occur corresponding to one of the halt branches of Fig. 2, but it is not clear if they were legitimate halts or halts due to improper execution of the program.) If more or less identical problems do occur there, it would probably be a good assumption that it is the other area of memory being checked that is at fault and not those portions that contained our diagnostic program.

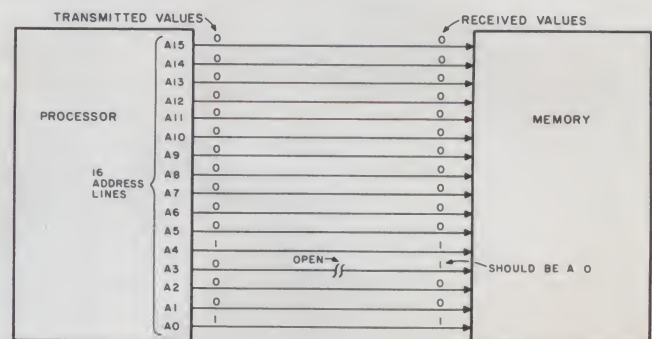


Fig. 3. The processor tries to address location 17 but the open line (A₃) causes location 25 to be addressed. This defect will result in a halt on branch 2 of the flowchart of Fig. 2.

Moving the diagnostic program around in this manner and running it in several different locations is a good way for the operator to more or less reassure himself that the program is being executed properly in at least one of the locations. One alternative to this manual moving of the program would be to have the program *relocate itself* several times. However, a program that would move itself, even when the memory it is currently residing in is bad, would be difficult if not impossible to write. It would require at least some minimum amount of defect-free memory from which to work.

Most memory ills will normally leave at least some portion of the memory intact for our diagnostic program (otherwise the problem would probably be obvious and easy to find). Therefore, the best procedure for the hobbyist might be to load his diagnostic program into several locations until he finds a place where it seems to be executed properly. From there he can use the program to troubleshoot the other areas of memory.

Beware of Variations

Since no program listings are given here for any specific system, the reader who wants to create such a memory diagnostic program would have to write a program compatible with his own system. Hardly anyone ever implements suggestions from a magazine article verbatim. Since most people implementing the project will see improvements or make modifications to suit their own application, a word of warning is given here concerning the memory check.

It may not seem worthwhile to actually walk a 1 through each byte. After it has been verified that all 0s can be written into the byte, why not try to skip the walking bit part and just attempt to store all 1s there and then check to see if they are indeed stored there? Consider what would happen if two

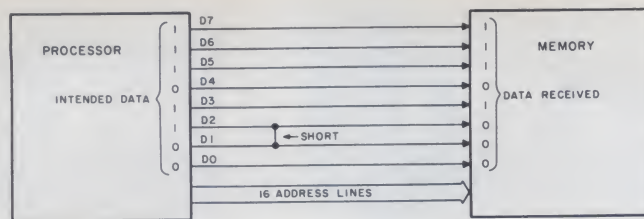


Fig. 4. The processor attempts to send binary 11101100 to the memory. Because of the short between data lines D₁ and D₂, the actual value received by the memory is binary 11101000. The diagnostic software indicated by Fig. 2 would detect this, and a halt on branch 3 would result.

data input lines were shorted together. The shorted lines will always be at the same logic level, so when we store all 0s and then later all 1s, everything looks normal. On the other hand, if a 1 is walked through, then at some point during the walk the two shorted lines will be required to be at different logic levels. Of course, they will not be because of the short, and the machine will halt on branch 3 in Fig. 2.

Error Reporting and Correcting

In some instances when a program crashes because of a memory error, it is obvious to the operator because of all the output trash. In other instances, the effect may be a subtle or transient one, and hardly even noticeable to the operator. If no mistakes can be tolerated (whether they are obvious to the user or not), there are methods in existence that provide a continuous check on the memory even while another program is running. These are especially helpful in detecting and even correcting data from an intermittent section of memory. There are various schemes used, but most employ some kind of error checking code.

With such a code, any byte written into memory has some of its bits dedicated to the actual value of the quantity we wish to store. The remaining bits serve as error checking bits and are usually generated at the time of storage. Such an error checking system is provided by Data General of Southboro MA for their minicom-

puters. Unlike simple parity, their method detects and corrects all single bit errors and most multiple bit errors. (This includes errors in the check bits as well as the data bits.) They even provide for optional error reporting so that minor error problems can be corrected later by remedial maintenance. This reporting scheme will report the offending module, word, and bit while continuing to run through the current program.

Finding errors and correcting them while the program continues to run has its disadvantages. It requires more memory bits per word and extra hardware, so it is normally used only in applications where ultra-high reliability is required. Such applications include security digital communications, certain process control, and vital defense applications.

Such error detecting and correcting does not appear very compatible with our eight-bit micros at this time. Perhaps some manufacturer will come up with a multi-byte/hardware option that could be geared with the appropriate software to correct and report errors. I may be wrong, but I don't see this type of error detecting and correcting as being very important to the average hobbyist because of the extra cost and slower speed. (Speeds for eight-bit processors would be slower if extra bytes for check bits were included.) After all, for most hobbyist applications a computer failure will not send a missile on its way to

Russia or have any other such drastic effect.

And In Conclusion

I hope this article will stimulate others to develop better diagnostic software. Perhaps someone has had some unique problem with his system that existing diagnostic software is incapable of detecting. If solutions for all these little problems could be consolidated, the result would be a fantastic software package. The solution to many problems could be flowcharted and aired (perhaps in *Kilobaud*) for general use for all processor types. Of course, some problems would be unique to a particular architecture or processor type. This latter type of software is the kind many of us would like to see manufacturers supply. I know that my own consideration of whether or not to purchase a microcomputer involves the availability of diagnostic software for that particular system.

No diagnostic program can ever touch all the bases. There are just too many possible defects to allow a program of reasonable length to detect them all. No matter how high the manufacturer's quality control standards are, some defects will eventually show themselves in some of his products. The appearance of some defects might have nothing to do with the original quality control during manufacture but might be caused by extreme operating conditions or abuse. For the most part, however, troublefree operation can be closely approximated by the manufacturer's use of quality ICs, PC boards, and other components. In the meantime, when those bugs do occur, just hope it's not too serious and let your diagnostic software do its thing. With a little clever programming, you might even arrange for the machine to give you a hard copy (or perhaps a display on a terminal) of just where the problem is. ■

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Understand Your Interrupts !

... real time clock applications

A vectored interrupt scheme is not only worthwhile, but necessary, if you have a system with several devices which will be generating interrupts. A real time clock can be put to good use in real-time game applications, time of day, and for determining analog input sampling rates . . . just to name a few. William has done a fine job of presenting both circuits, and the theory of operation, as a construction project for an Altair bus proto board. He estimates that the RTC could be built for about \$12 plus the crystal and the vectored interrupt board for about \$10. — John.

With my microcomputer system finally up to speed (although one's system is never really finished) I decided to attack the long promised applications software. My wife has been hearing about zone heating, a home security system, and a kitchen inventory program while I've been buying this board or building that board. At some point, one must justify the expense. So, on to the applications, right?

Wrong! Taking a closer look at the proposed soft-

ware, one point stood out. Most of the new functions would require some knowledge of the time (either elapsed or time of day). Clearly, before plunging into the new programs, a real time clock was needed.

Having decided on software timekeeping (explained later) another bug appeared. If the real time clock (RTC) was to use interrupts, then either the interrupt service overhead would increase or the system needed a priority interrupt device (sometimes

called a vectored interrupt). Since the 8080 is designed with eight priority interrupt lines the vectored interrupt module seemed a good place to start.

8080 Interrupt Concepts

The processor interrupt is a technique, usually implemented in the hardware of the microprocessor, which

temporarily suspends normal program execution while some other operations (called an interrupt service routine) are performed. When the interrupt service routine is completed, control is returned to the interrupted program exactly where it left off.

The process may best be understood by way of an

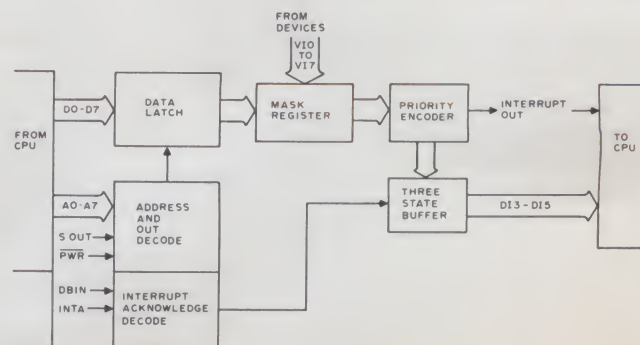


Fig. 1. Vectored interrupt block diagram.

example. Suppose we have a system with a real time clock which produces a signal once per second. If this signal is connected to the interrupt line of the microprocessor an RTC interrupt is generated. If the interrupt enable flip-flop in the microprocessor is set (by the Enable Interrupt instruction) an RTC interrupt will occur when the clock pulse is active.

The 8080 will not honor the interrupt request until it is in the M1 state, that is, when the first byte fetch of a possible multi-byte instruction is about to be executed. At that time, the current contents of the program counter (PC) will be pushed onto the stack. The processor then issues an interrupt acknowledge (INTA) and the data bus in signal (DBIN). The significance of these two signals will be seen later. If there is no vectored interrupt board in the system the processor will branch to location 70g.

At location 70g there must be an interrupt service routine or a jump instruction to the beginning of the service routine. In this simple example, since there is only one device able to generate an interrupt, there is no question about where the interrupt request originated. The service routine will take care of the bookkeeping (increment a seconds counter location, etc.), enable the interrupt flip-flop again (EI) and return to the main program (RET).

With the RET instruction, the previous contents of the PC will be popped off the stack and normal program execution resumes. It should be obvious that this is an efficient method for servicing

RST 0	0
RST 1	10
RST 2	20
RST 3	30
RST 4	40
RST 5	50
RST 6	60
RST 7	70

(all locations in octal)

Table 1.

slow or low frequency devices.

If the system has more than one device able to request an interrupt, the interrupt service routine must be more sophisticated. The service routine must poll the status registers of the devices to determine which device requested the interrupt, and then branch to the service routine for that device. This is a workable technique when there are few devices generating interrupt requests, and when device speeds are not similar.

Consider the case where the system has an RTC which must be serviced once per second, a Teletype which can print ten characters per second, and a cassette tape drive which is reading characters at thirty per second. Here we have a device which must be serviced (the cassette tape) or data will be lost; a clock which must be serviced to maintain the correct time, and a slower Teletype which

can be run when the other devices are not busy.

For the single level interrupt scheme described above, the simplistic approach would be to poll the devices according to some priority scheme. This means that we would check the tape drive first, then the RTC and last the Teletype. An important concept has entered the picture: priority. That means that some devices (perhaps independent of speed) are more important than others. The multi-device single level interrupt situation is workable.

Vectored Interrupt Operation

As the number of devices increases or the speeds of the devices increase, the amount of time spent in polling the devices becomes more critical. One would like the interrupt system to have the capability to branch to the service routine for each device directly, and to service devices according to some priority schedule. This

process is possible with the 8080.

When the processor acknowledges an interrupt, it sets the INTA and DBIN signals on the bus. This allows the interrupting device to place one of the RST X instructions (where X is 0 to 7) on the data bus. If the RTC is interrupt device 0 it would place a RST 0 instruction on the bus when both INTA and DBIN are valid. The RST 0 instruction causes the processor to branch to location 0, where the RTC service routine (or a pointer to it) would reside. If the Teletype is interrupt device 6, it would insert an RST 6 instruction and the processor would branch to location 60g. Thus the interrupting device may define the address of its service routine (or a pointer to it). The RST X instructions cause branching to the locations shown in Table 1.

This type of interrupt handling is called vectored

```

SMASK:    LDA    MASKW    ; load the mask word
          OUT    VIBRD    ; output to the VI board
          JMP    EXEC     ; go back to the executive
MASKW:    DS     1        ; 1 word of storage for the mask word
VIBRD:    EQU    XX       ; device number of the VI board

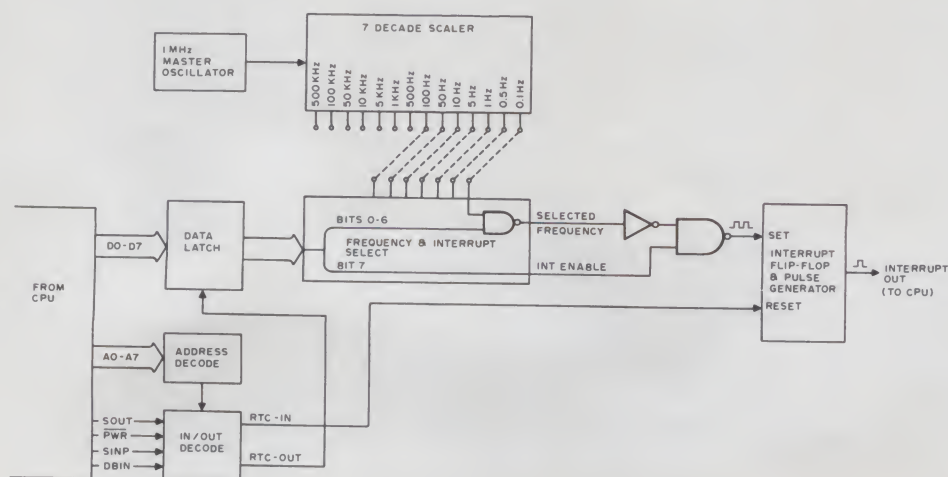
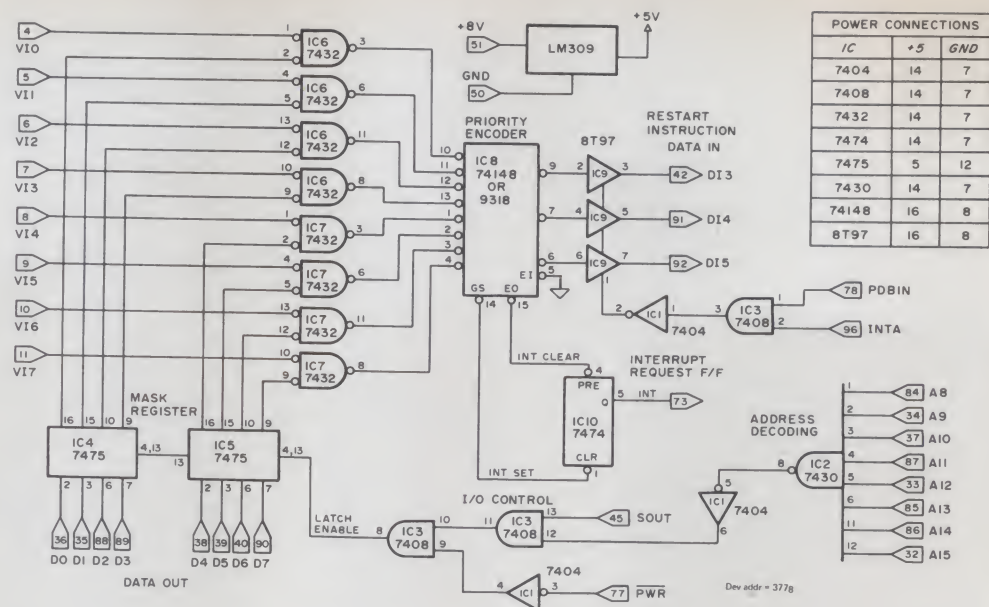
Typical service routine:
TSERV:    PUSH    B        ; save registers
          PUSH    D
          PUSH    H
          (EI)           ; optional EI here allows other
                          ; devices to interrupt this one
          .              ; service this device in the
                          ; normal manner: IN, OUT, etc.
          POP     H        ; restore registers
          POP     D
          POP     B
          (E1)           ; enable interrupts here (or above).
          RET            ; return to main

Example of service routine protecting its priority:
PSERV:    PUSH    B        ; save registers
          PUSH    D
          PUSH    H
          LDA     MYMSK    ; load special mask word for
                          ; this device
          OUT     VIBRD    ; and output to VI board
          .              ; service device
          .
          LDA     MASKW    ; load old mask word
          OUT     VIBRD    ; and output to VI board
          POP     H        ; restore registers
          POP     D
          POP     B
          EI           ; don't forget to enable interrupts
          RET            ; return to main program
MYMSK:    EQU    277g     ; mask word to mask out all
                          ; devices but this one
VIBRD:    EQU    XX       ; VI board device number
MASKW:    DS     1        ; storage for mask word

```

Program A. Sample software for the vectored interrupt circuits.

To take full advantage of the 8080 interrupt structure and provide for priority handling, one must build a separate board through which all interrupt requests are channeled. This board receives an interrupt request from a device, passes or holds the request based upon the priority of the device, formulates the X part of the RST X instruction, and generates an interrupt on the interrupt bus line of the processor. To understand its function, let's look at the block diagram and the schematic.



Active VI line	Priority	RST X
0	7	RST 0
1	6	RST 1
2	5	RST 2
3	4	RST 3
4	3	RST 4
5	2	RST 5
6	1	RST 6
7	0	RST 7

Table 2.

become clearer.

Assume the RTC is on VI line 0, the tape deck on VI line 2, and the Teletype on VI line 6. If the RTC and the tape drive request an interrupt at the same instant, the RTC will be serviced first, because it has highest priority. When that request has been honored, the priority encoder will place the RST 2 instruction on the bus and the processor will service the tape drive. If all the requests have been honored the 74148 will clear the interrupt flip-flop.

If the tape drive service routine enables the processor interrupts upon entering (with the EI instruction) and

an RTC interrupt request comes along, the vectored interrupt board will honor the RTC request, interrupt the tape drive service routine to service the RTC and then return to the tape service routine. The priority of requests may be preserved even while servicing another interrupting device.

The value of the interrupt mask deserves a word of mention also. Suppose we had a device which when serviced should not be interrupted, such as a disk drive. Since the data transfer from disks is usually done by direct memory access (DMA), and one cannot stop the disk to service an RTC or Teletype,

some means of suspending (not cancelling) interrupt requests is necessary. In this case, the disk service routine could take the current mask word (stored in memory), mask out all devices but itself, and output this new mask word to the vectored interrupt board. When leaving the disk service routine, the old mask word could be output to the vectored interrupt board to re-enable any pending interrupt requests. Note that this procedure only suspends the other interrupt requests, it does not ignore the requests altogether. Program A is a sample of a typical interrupt service routine along with an interrupt service routine which protects its own priority.

A Programmable Real Time Clock

With the vectored interrupt problem solved, I began to investigate methods of implementing a user-programmable real time clock

500 kHz	100 kHz
50 kHz	10 kHz
5 kHz	1 kHz
500 Hz	100 Hz
50 Hz	10 Hz
5 Hz	1 Hz
0.5 Hz	0.1 Hz

Although the higher frequencies are available, they may not be of use depending upon the particular system. The following frequencies were chosen for the seven possible:

1 kHz	500 Hz
100 Hz	10 Hz
1 Hz	0.5 Hz
0.1 Hz	

Table 3.

(RTC). The RTC is basically a device for maintaining the time of day and/or measuring elapsed time for events within the computer system. There are two basic approaches to the design of a real time clock.

One may build a device which generates an interrupt for each RTC cycle and have the software take care of the bookkeeping, or one may design a device which has its own dedicated circuitry with data ports to the computer for the processor to sample. I

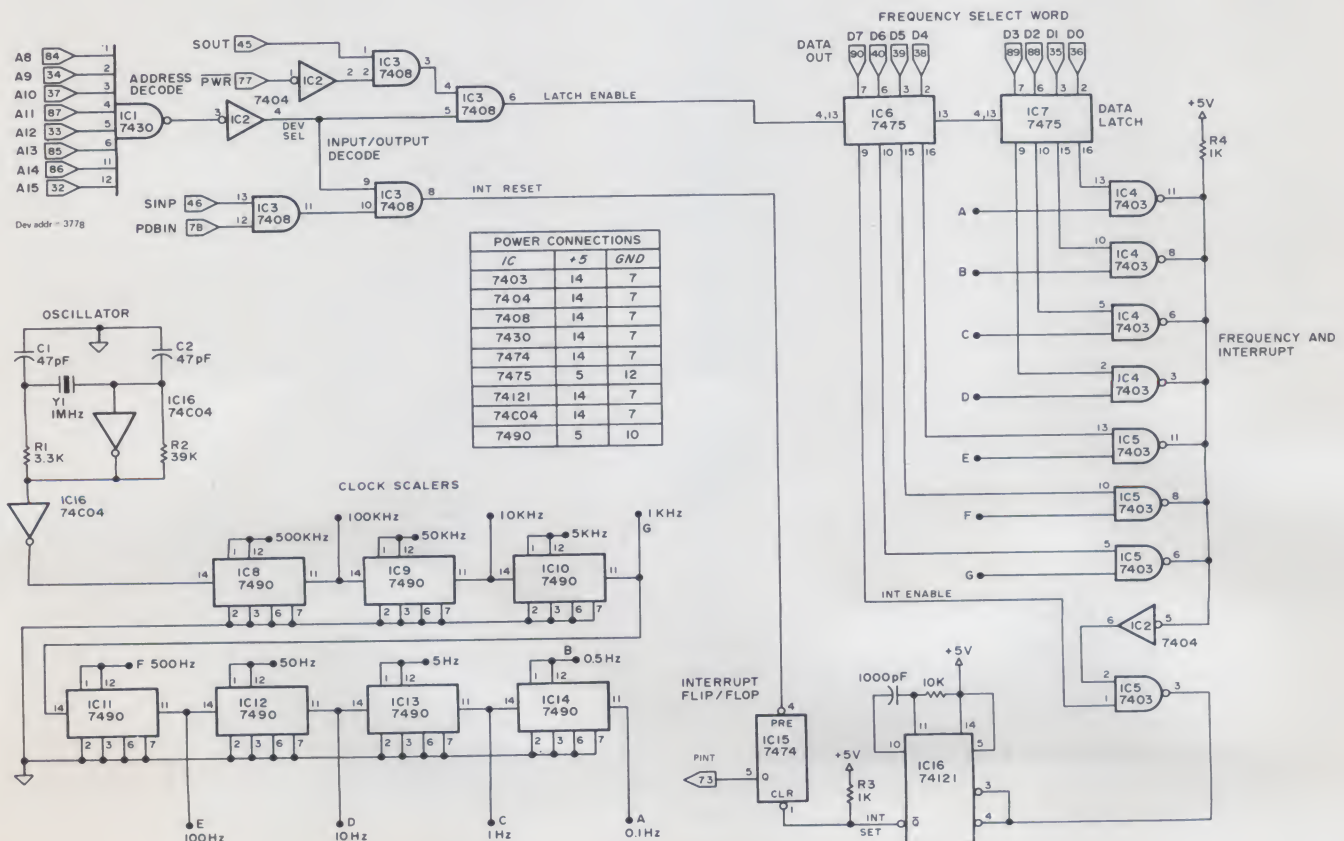


Fig. 4. Logic diagram for RTC circuitry.

have chosen the first approach for reasons of flexibility.

As indicated in the block diagram (Fig. 3) and the schematic (Fig. 4) the RTC consists of three main sections: the master oscillator or clock, the scaler circuits, and the address and interrupt circuitry. All communications with the RTC are accomplished with IN and OUT instructions and the clock cycles are seen by the processor as interrupts.

The address circuitry is typical for the Altair bus and could be adapted to other processor systems. When the RTC is being addressed with an OUT instruction the data on the data bus is latched by the two 7475 4-bit latches. Seven of these data bits (0 to 6) are used for frequency selection while bit 7 is used to set or reset the RTC interrupt enable flip-flop.

The master clock is built around a 1 MHz crystal using a CMOS inverter with passive RC circuitry. The output of the master clock is a 1 MHz square wave of TTL levels. (You could use the processor clock with the appropriate scaling.) The master clock drives a series of 7490 decade counters. Table 3 shows the frequencies that are available when the clock is scaled through seven decades.

With this range of frequencies, the RTC may generate anywhere from one interrupt every ten seconds to one thousand interrupts per second. The frequency used to generate the interrupts is determined by the Frequency Select Word which has been output from the processor and latched by the RTC. This data (one bit at a time, 0-6) is ANDed with the various frequencies. Thus by setting bit 0, the 0.1 Hz signal will be passed through the open collector NAND gates.

The selected frequency is then passed to the interrupt gate. If the interrupt enable has been set (bit 7), the signal will proceed to the interrupt bus (either vectored or single

level interrupt). When the RTC is serviced by the processor, the service routine must issue an IN RTC instruction to clear the interrupt flip-flop on the RTC board. This is the only requirement of the service routine. Typically the service routine would increment the various storage locations used as counters to record the passage of another unit of time. Examples of a software time of day clock are given in Program B.

If desired, the RTC interrupts may be completely disabled by either setting the data to be latched by the RTC such that none of the seven available frequencies are selected or the software

may reset the interrupt enable gate (i.e. set bit 7 to 0 in the data to be latched by the RTC). Changing frequencies is accomplished by sending a new Frequency Select Word to the RTC latches.

The one-shot (74121) has been used between the interrupt flip-flop and the interrupt gate for the following reason: If the duty cycle of the RTC is 50% (square wave) and the RTC frequency is low (say 0.1 Hz to 100 Hz), it is very likely that the service routine will complete before the signal on the interrupt bus changes state. Thus, to prevent multiple interrupts on one RTC cycle, the one-shot is used to generate an interrupt pulse. The pulse

width should be long enough to be seen by the flip-flop. A pulse width of 5 to 10 usec. should be sufficient for most systems.

The RTC and the VI board were built separately during the design stage (using Vector 3677-2 44-pin boards). Since the circuitry for both modules is moderate, I decided to combine both on one board (such as the Vector 8800V).

With the RTC and the VI finished, I began thinking about the applications software again. But a package as comprehensive as this should probably have a floppy disk, and maybe a DMA controller. Oh well, thank heaven for push-down stacks! ■

Selecting frequency and interrupt enable:

```
SETF:    LDA    FREQ1    ; get the frequency desired
          MOV    B,A      ; save it in register B
          LDA    INTON    ; get the interrupt on word
          ADD    B        ; add the freq. with the int. sel.
          OUT    RTC      ; output to the RTC
          JMP    EXEC     ; go back to the executive

FREQ1:    EQU    4        ; select 1 Hz
INTON:    EQU    200h     ; set bit 7 for interrupt enable
RTC:      EQU    XX       ; RTC device code
```

RTC interrupt service routine:

```
RTCIS:    PUSH    PSW     ; save ac and flags
          IN      RTC     ; in from RTC to clear interrupt
          EI      ; re-enable interrupts for other devices
          .        ; service routine continues
          .
          POP     PSW     ; restore ac and flags
          RET      ; return to main program
```

Software time of day routine:

```
STOD:    LDA    SECS     ; get seconds storage location
          INR    A        ; increment by 1
          STA    SECS     ; restore seconds counter
          CPI    074h     ; compare to 6010
          JNZ    END      ; not 60, go home
          SUB    A        ; set ac to 0
          STA    SECS     ; set secs counter to zero
          LDA    MINS     ; get minutes counter
          INR    A        ; increment by 1
          STA    MINS     ; restore minutes counter
          CPI    074h     ; compare to 6010
          JNZ    END      ; not 60, go home
          SUB    A        ; =60, set ac to zero
          STA    MINS     ; set minutes to zero
          LDA    HRS      ; load hour counter
          INR    A        ; increment by 1
          STA    HRS      ; restore hour counter
          CPI    030h     ; compare to 2410
          JNZ    END      ; not 24, go home
          SUB    A        ; set ac to zero
          STA    HRS      ; set hour counter to zero
          POP     PSW     ; restore ac and flags
          RET      ; return to main program

SECS:     DS      1        ; seconds counter
MINS:     DS      1        ; minutes counter
HRS:      DS      1        ; hours counter
```

Other routines may determine time of day by examining locations: HRS, MINS, SECS. For elapsed time, move HRS, MINS, SECS to another location at start of event, then get new HRS, MINS, SECS at end of event. Subtracting before from after will yield elapsed time of the event.

Program B. Real time clock software.

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KILOBAUD KCLASSROOM NO. 5

... hardware logical functions



George Young
Sierra High School
Tollhouse CA 93667

In session four we learned how to make simple printed circuit boards. Your initial efforts may have left a bit to be desired. Patience: A little practice will have you making fairly professional-looking circuit boards. And we finally got a power supply and voltage regulator into our console before we went broke buying batteries.

Preview

In this class we will meet the other members of the NAND gate family and intro-

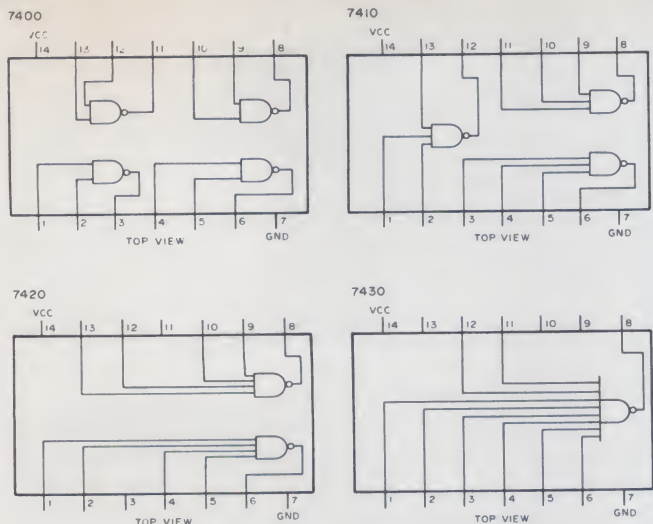


Fig. 1. NAND family pin-outs.

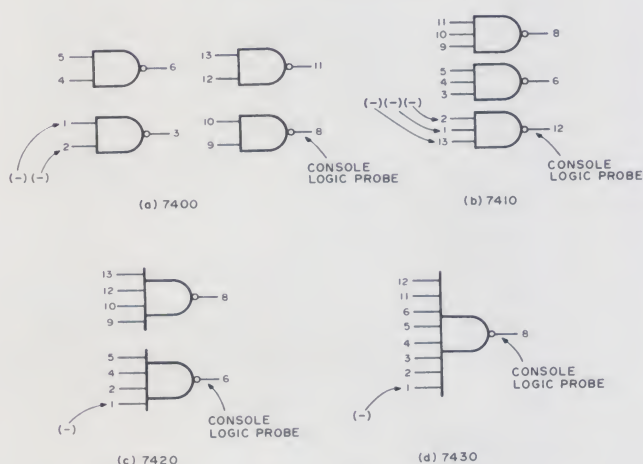


Fig. 2. Test circuits for the 7400, 7410, 7420 and 7430.

duce you to the NOR gate. Then it would be "logical" to have you get acquainted with all four logic functions: AND, NAND, OR and NOR. You'll need a copy of *Kilobaud* #5 (May) and the article by Pete Stark (page 56) for reference material.

We will also change the experimental format that we have been using. You were given rather detailed directions, equipment lists, and so on up to now for each experiment. You should know enough now to get by without all this hand-holding.

I'm going to give you a problem, which is usually the way it happens anyway. Now, electronics is hard enough to learn without some guy throwing out problems for you to solve. Bear with me —

I think you'll enjoy the new approach even more than the one used in previous sessions. We are going to create a typical problem in digital electronics, then solve it on the breadboard. This is really what Superstrips are for.

The 7410 Experiment # 19

Problem: To build an electronic dice game. It must display the numbers 1,2,3,4,5, & 6.

Solution: Use the 7-segment readout as a die. We will need a binary counter that goes to eight. Use gates to eliminate the seven and the zero.

Procedure: Build just one die first. Then you can design the electronic dice game. Three flip-flops will divide by

eight. We will build this first on the Superstrip. You've studied this all before in different experiments, but not assembled in just this fashion.

First test the 7410 (see Fig. 1 and 2). I'll lead you through this again, but you should be approaching the point where that is no longer necessary. The 7410 goes in the Superstrip. Connect power and ground. Connect the console logic probe to pin 12. It should be low because the moment you connect power and ground to the 7410, the inputs all go high. Ground an input which corresponds to the output on pin 12. The output should go high. Referring to Fig. 2b, let's assume you picked pin 13 first. Next ground pin 1. The output should go high. Next ground pin 2. Again the output should go high. Leave the wire connected to pin 2. With another wire ground pin 1, and with still another wire ground pin 13. The output should remain high. We should find that the output for any NAND gate is low

only if *all* inputs are high (or floating). In other words, it is performing an AND function. Test the remaining two NAND sections.

The next steps should be analyzed carefully. Here's how the pros do it. First we get a circuit to work. After it is functioning correctly, we modify it to make it do something different. Note that only the most optimistic technician connects everything first and then applies power. (If you didn't read Ken Knecht's article in issue #5, do it now.)

Second, connect the circuit shown in Fig. 3a. I deliberately left the pin-outs off so you would have to look them up. You might just as well make the errors here as me. Dig out your earlier experiments on the flip-flops and decoders and write in all the pin numbers. Or better still, if you have obtained your own data manual, use that to get the pin-outs. May I assume that the 7473 and the 7448 chips are already tested and known to be good?

When Fig. 3a is functional,

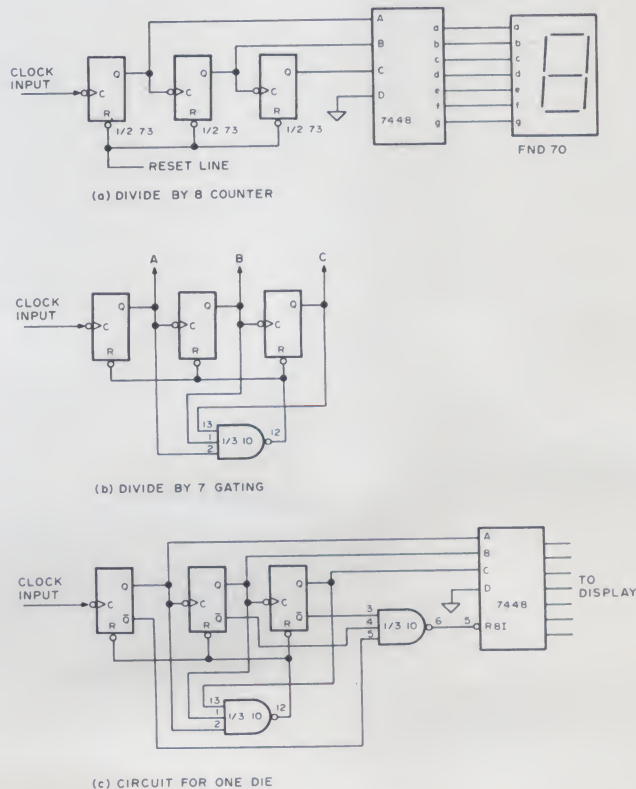


Fig. 3. 7410 circuits.

the 7-segment display will cycle from zero to seven and back again. Use the console clock to clock the first 7473 flip-flop. Make sure this circuit works before we proceed. Since a die does not have a seven, we need to eliminate it from our display. In Fig. 3b we add the 3-input NAND gate section to detect a count of seven. The three inputs to the 7410 will go high on a count of 7. The 7410 output will go low, resetting the counter to zero. The net effect is to eliminate the numeral 7 from our display. Now it should display 0,1,2,3,4,5, and 6, but no 7.

The next step is to find a way to eliminate the zero from the display since it also does not occur in a dice game.

Blanking the Zero Experiment #20

Problem: How to get rid of the zero on our dice.

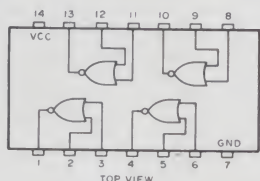
Solution: In the previous experiment we eliminated the seven. Now, whenever the count reaches seven the flip-flops will be reset (Q outputs low and the \bar{Q} outputs high) and, of course, we will have the same condition when the count reaches zero. What we

need is a circuit that will sense this condition and eliminate the zero from the display.

Once again, the Q outputs are low and the \bar{Q} outputs are high when we reach zero. As shown in Fig. 3a we can devise a very simple solution to our problem by simply taking the \bar{Q} outputs from all three flip-flops and wiring them into one of the unused gates of the 7410. When all of the inputs to the gate are high the output will drop low. This output should be connected to Pin 5 of the 7448 decoder. Pin 5 is the ripple blanking input (RBI). When this input goes low the entire display is blanked.

Procedure: Simply wire in one of the unused gates in the 7410 (see Fig. 3c). Our FND 70 die should now display 1,2,3,4,5, and 6. The number seven should not be displayed and if a zero turns up, the display will be blank.

Now you can design an electronic dice game on the Superstrip. You'll need a second counter, decoder, and FND 70. The dice are rolled with the clock and stopped with the console start-stop control.



(a) 7402 PIN OUTS

INPUTS		OUTPUT
A	B	C
0	0	
0	1	
1	0	
1	1	



(b) 7402 TEST CIRCUIT

Fig. 4. 7402 pin-outs and test circuit.

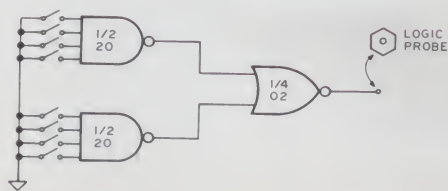


Fig. 5. Switch closure detection circuit.

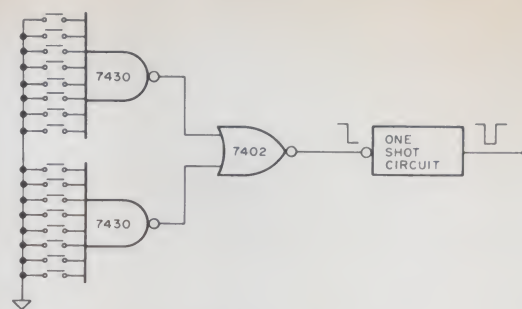


Fig. 6. Switch circuit with 7430 Nand gates (drawn incorrectly).

The 7402 and 7420 Experiment #21

Problem: I have eight pushbutton switches. I need a circuit to detect when any one of the switches closes to ground. I need a low output from the circuit when any one of the switches is closed. (Don't run out and buy eight switches. We are going to fake them with a wire.)

Solution: In this first solution we are going to use a 7420 NAND gate and a 7402 NOR gate. For the NAND function the output is low only if all inputs are high. For the NOR function, the output is high only if all inputs are low.

Procedure: First test the NAND gate. The 7420 is a dual-4 input NAND gate. Test it like the 7410. This time there are only two sections to test, but each section has four inputs.

Next test the 7402 NOR gate (see Fig. 4). This is a quad-2 input gate. For the NOR function the output is high only if all inputs are low and the output will be low with either input high. Why don't you fill in the truth table (Fig. 4b) for the 7402 as you check it out. Plug it in to the Superstrip, connect power and ground, and test all 4 sections of the 7402. (Did you notice the OR function being performed after completing the truth table? With input A or input B high the output is low.)

Now Fig. 5 can be put together on the console breadboard. One half of the 7420 feeds one NOR gate input. The other half of the 7420 feeds the other NOR

input. A wire from ground takes the place of the eight pushbutton switches. Connecting any 7420 input to ground (any switch closure) forces the 7420 output high. This makes one of the inputs to the 7402 high, causing its output to go low. Thus we have a circuit that will detect when any one of eight switches is closed to ground.

The Hex Keyboard Experiment #22

Problem: We are going to build a computer later in the course. One of the things we will need is an INPUT device to communicate with our machine. We could use toggle switches for this purpose, but they are expensive, and a dozen or so will set us back around \$15. Toggle switches are also a very slow method of getting data into a computer. We will use a hex keyboard. We will use a keypad from a defunct hand-held calculator. If your calculator hasn't gone south yet, these are available for about \$1.50 from advertisers such as Poly Paks. Combining the keypad with several TTL ICs produces a computer keyboard that will enter data as fast as you can make your fingers fly.

In the hex keyboard, we have sixteen keys that correspond to the hexadecimal number system. We need a circuit to detect when any one of the keys on the hex keyboard is pushed.

Solution: Two 7430 NAND gates (same as the 7420 NAND, except has 8 inputs) and a 7402 NOR gate are used to detect when a key on the hex keyboard is

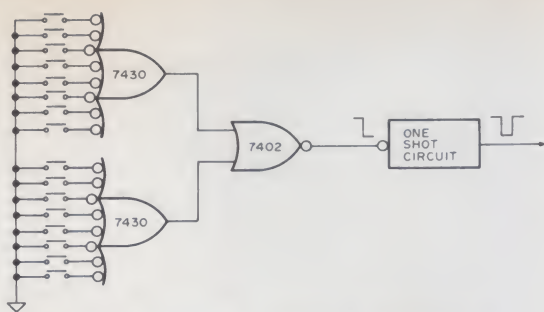


Fig. 7. Logic symbols reflect the logic functions.

closed. The output of the NOR gate is a negative-going pulse that triggers a circuit called a one-shot monostable multivibrator which will output a single pulse. (We will get to one-shots a little later in the course.)

Procedure: Fig. 6 gives the circuit. Fig. 6 shows the circuit the way I have been teaching you the gates. I have done this deliberately until now. Fig. 6 is *incorrectly drawn*. The correct method of drawing the circuit is shown in Fig. 7.

In the interest of simplicity, I've ignored this point until now. We are using active low inputs on the 7430 in Figs. 6 and 7; the logic function is the OR function. We want to detect when pin 1 OR pin 2, OR pin 3 and so on goes low. Thus we would draw the circuit as shown in Fig. 7 using the OR symbol and placing the little circles (state indicators — "indicating the state") on the inputs, and not on the output. By placing the circles on the inputs we are indicating that the gate is looking for active low inputs (i.e., the switch taking the input to ground). If a gate has a circle at the output (such as the 7402 NOR) the output is low when the logic function of the gate (OR) is being performed. All of this is covered in Pete Stark's article in the May issue. Please note that both circuits in Figs. 6 and 7 function in exactly the same way. A switch closure to ground triggers the one-shot. We have simply made the logic diagram reflect the logic function that is being performed.

You can breadboard the hex keyboard circuit of Fig. 7 as follows. Replace the one-shot with an LED. Connect the LED between the 7402 output and ground. If you have two 7430s, then proceed. If you have only one 7430, then use it as the upper 7430 in the figure. The other input to the 7402 is normally low if none of the eight inputs of the lower 7430 are

tive-going output for any switch closure.

Experiment #23 The AND Function

Problem: I have two switches and an LED. I want to turn on the LED with a high but only if both switches are closed to a high.

Solution: Use a 7408 quad 2-input AND gate.

Procedure: Refer to Fig. 8a which gives the pin-outs for the 7408. If you have a 7408, it can be connected on the breadboard as shown in Fig. 8b. If you try the circuit of Fig. 8b, you'll find that it does not work. Regardless of whether the switches are closed or not, the LED is on. Only if we ground one of the inputs to the 7408 will the LED go off. This is because the 7408 inputs are floating

as will anything between about 100 and 1500 Ohms; use what you have available. (By the way, don't forget the current-limiting resistor between the 7408 output and the LED.) Now we have a solution to the original problem. The LED will be on only if both switches are closed to +.

But you say you don't have a 7408? Well, we can still solve the problem with what we do have. We have a 7400 and an inverter.

If we follow the NAND gate with an inverter, we also invert the logic function. That is, a NAND followed by an inverter will give us the AND function. So even if you do not have a 7408, you can still solve the problem with a 7400 and an inverter. Fig. 8d gives the details.

We don't have to use a 7404 for the inverter function, because if both inputs of the 7400 NAND gate are connected together so that there is only one input instead of two, this configuration will function as an inverter instead of as a NAND gate. This solution is shown in Fig. 8e. To form the AND function from the NAND function, add an inverter to the NAND gate.

Hey, will this also work for the NOR function? You better believe it. The OR function can be stated as follows: The output is high if any input is high. To form the OR function from the NOR function, add an inverter to the NOR gate.

Most of the time it will be better to use the 7408 AND gate or the 7432 NOR gate to obtain the AND and the OR functions instead of using the NAND plus the inverter or the NOR plus the inverter. There will be times, however, when this trick will come in handy, such as in this experiment where we do not have a 7408, but we do have a 7400.

Experiment #24 The NOR Function from the NAND

Problem: I have several

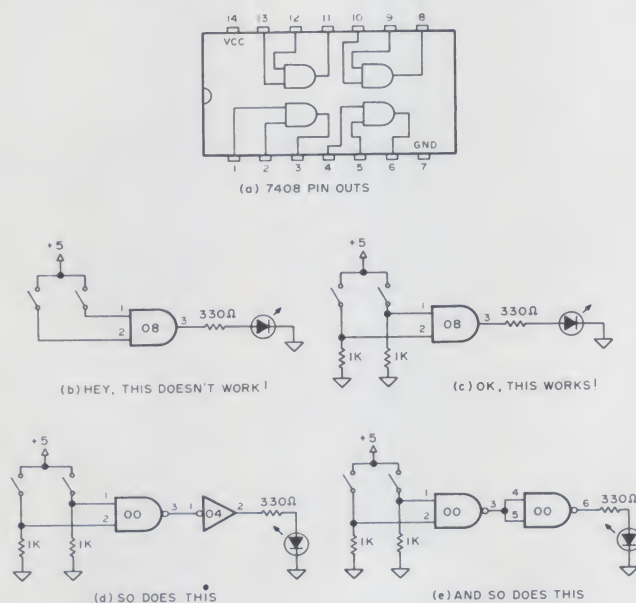


Fig. 8. Experiment #23, the AND function.

closed. So we can bypass the lower 7430 by grounding the input of the 7402 that would be fed by the lower 7430. Any closure of any of the eight inputs of the upper 7430 will then turn off the LED. By moving the one 7430 that you do have to the lower position, and grounding the upper input to the 7402, you can then simulate any of sixteen key closures and verify that you get a nega-

tive-going output for any switch closure.

Let's add two resistors to the 7408 inputs to pull them low unless the switches are both closed as shown in Fig. 8c. These two resistors are not critical. We have to use a value that the 7408 will interpret as a low on the inputs. A 1k will work very nicely here,

NAND gates, but this circuit that I want to try on the console breadboard uses a NOR gate. I'll have to run out and buy a NOR gate to try the circuit. Hit WAIT (or STOP, HALT, or whatever)!

Solution: Yes, you can run out and buy the IC, and when you decide to actually build the circuit on a PC board this is the path that you should take. But it is also possible to build the NOR gate function from a quad 2-input NAND gate. In fact, it is possible to build all four logic functions from *either* quad 2-input

second section of the 7400 as an inverter. To do this simply connect both inputs together and use them as one input. This performs an inverter function. Now the output of the inverter section is high only if both inputs is high, and this is equivalent to the AND function.

If we add a pair of inverters ahead of the inputs to a NAND gate as shown in Fig. 9c, we can get the output high if either input is high. This is the OR function. You will notice the 7400 has been drawn as an OR gate. Output

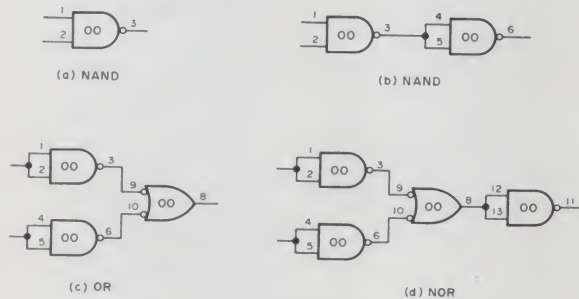


Fig. 9. Experiment #24, AND, NAND, OR and NOR from one quad 2-input gate.

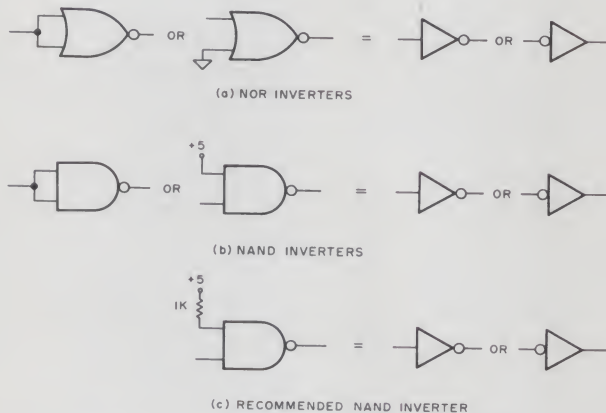


Fig. 10. Inverters from NOR and NAND gates.

gate. Let's do it with the 7400.

Procedure: Referring to Fig. 9, put the 7400 in the Superstrip. Now darn it, don't forget power and ground first! Since the 7400 is the NAND function, we have this function just as soon as we connect power and ground. Output low only if all inputs high = NAND function. Now connect a

high only if both inputs are low is the NOR function. We can get this by following the circuit of Fig. 9c with an inverter. Fig. 9d then gives us the NOR function from the NAND function. In fact, in this process we formed all four logic functions from a quad 2-input NAND gate.

The same thing can be done with the NOR gate. Take a 7402 and see if you

		A	B	OUTPUT
(a)	AND	0	0	0
		0	1	0
		1	1	1
(b)	NAND	0	0	1
		0	1	1
		1	1	0
(c)	OR	0	0	0
		0	1	1
		1	1	1
(d)	NOR	0	0	1
		0	1	0
		1	1	0

Fig. 11. Equivalent gates.

can make all four logic functions from it. The process is identical to that used in experiment #24. Try it ... see if you can do it.

Experiment #25 Inverters

Problem: I am out of 7404 sections and I need another inverter for my circuit.

Solution: Do you have any unused sections of 7400s or 7402s left?

Procedure: Inverters are often formed from unused gate sections. The 7400 in the preceding experiment was used as an inverter by simply tying both inputs together. This is one way to form an inverter from a 7400 section. A second way is to tie one input high and feed the signal in on the other input. You can tie the unused input directly to + but this is not the recommended method. IC manufacturers suggest tying unused inputs high through a resistor. Any resistor from about 470 to 3.3k Ohms will work. The usual value is 1k Ohm. Several unused inputs can be tied high through a single 1k resistor (see Fig. 10).

Unused NOR gate sections can also be used as inverters. Again both inputs can be tied together and treated as a single input to obtain the inverter function, or the unused input can be enabled

by grounding it (see Fig. 10).

Try all the circuits of Fig. 10 on the breadboard and verify that each inverter works just as well as a 7404 inverter section would.

Summary

During these first five sessions of Kilobaud Classroom I have tried to present the logic symbols for gates in a way that would be easiest for the student to learn them. In other words, I have not switched back and forth too much (until this session) showing how gates perform equivalent functions. For example, you will remember how I made one of the 7400 gates in Fig. 9c and 9d a "negated-input" OR? If the gate is performing an OR function (which it is in that case) then it should be drawn as an OR.

For the remainder of Kilobaud Classroom we will not be switching back and forth, and our logic diagrams will represent the logic function being performed as closely as possible.

Fig. 11 shows the four basic logic functions AND, NAND, OR and NOR along the left side with their equivalent OR/AND gates in the center column. The truth table shown with each pair will provide verification for the equivalent logic functions being performed.

Experiment 26

Purpose: To build a test instrument, the *Squawker*.

Equipment: 1. 555 integrated circuit; 2. small speaker scrounged from a defunct vest pocket transistor radio; 3. 9 volt transistor radio battery.

New symbols: none.

Circuit: The circuit for the console clock was given earlier. It is repeated here for those who have misplaced the original, or loaned out their copy of *Kilobaud*, or whatever.

Procedure: Lay out a PC board similar to that used for the console clock. Use a fixed resistor in place of the pot, and use a .1 mfd capacitor for the timing capacitor. Assemble all components in a box of some kind. See theory section.

Theory: An ohmmeter is used more often for continuity checks than it is for measuring resistance. Checking continuity occurs so often that many continuity testers have been placed on the market. A flashlight bulb, a battery and a pair of clip leads is one simple continuity tester. All usual forms of con-

tinuity testers suffer from one common fault: They all use the sense of vision for a go/no-go indication. This means that one must take his eyes off what he is doing to read the instrument. Even using peripheral vision to read the light bulb detracts from the job at hand. We need to use another of our senses to read the data.

This circuit was originally developed for an aircraft-mechanic friend of mine to enable him to time the magnetos on an aircraft engine without taking his eyes off the compass rose that he was using on the prop to check degrees of timing. There were commercial magneto timing buzzers available, but he wanted one that would be ultrasensitive. And so the *Squawker* was born.

Since it was originally developed, several hundred other uses have evolved for it. An electrical building inspector has one for checking house wiring. An electrical contractor has one for ringing out wires. Our auto shop instructor has three of them for checking point gaps and for troubleshooting electrical

wiring problems. Avionics technicians use them to ring out aircraft wiring harnesses during installation. Better make two of them, as one will probably end up as a gift for one of your friends.

The 7404 circuit in Experiment 1 of *Kilobaud Classroom* can also be used, but it takes four penlight cells and a diode to get a power pack for the 7404 *Squawker*. Since the 555 can use up to 18 volts for its power, the 9 volt transistor battery provides a very convenient manner of powering the 555 *Squawker*. The photos show both versions of the *Squawker*: the 7404 and the 555. Mount the unit in some kind of a container. A plastic box or an empty tuna fish can may be used. The photos show a sawed off extruded, rectangular piece of aluminum from a World War II surplus vacuum tube radio set. One end was plugged with plastic, the other with wood. One end is fixed permanently; other is removable to facilitate battery replacement. The entire circuit is attached to the removable end plug. A piece of cardboard, micarta

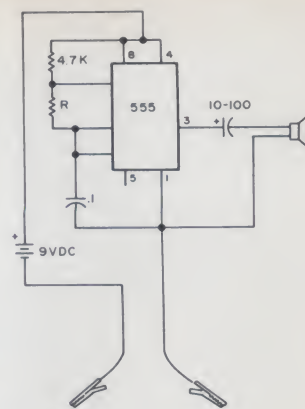


Fig. 12.

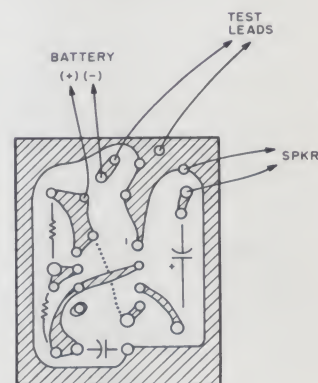


Fig. 13.



555 Squawker.



7474 Squawker.

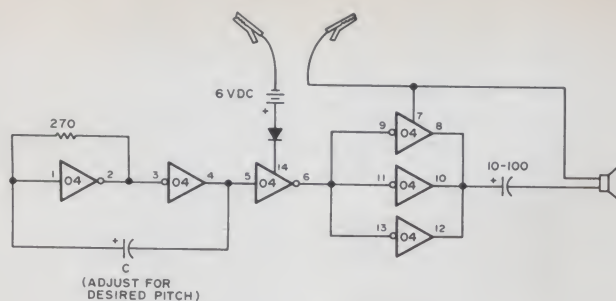


Fig. 14.

or wood supports and insulates the circuit board and battery, and provides a mounting for the speaker. The speaker was salvaged from a defunct vest pocket transistor radio. The transistor radio will furnish all the parts except the 555 chip, including the battery clips. Caution: do not trust the red and black wires to mean positive and negative. Check things out to be sure, since 555 chips die very quickly if connected with reverse polarity. Also, if you salvage the battery connector from a defunct 9 volt battery, the +

and - markings will get reversed when connected to a new 9 volt battery.

A section of reasonably flexible lamp cord makes a nice pair of test leads, and adding a pair of small alligator clips to the ends makes the test leads more functional. Connecting the two leads together connects the battery to the circuit, and causes the test device to squawk. Do not use the 555 circuit to test TTL circuitry: nine volts is *not* a TTL level.

It is a good idea to breadboard the entire circuit

before starting the PC board. Use the console to test your completed Squawker circuit, and set the tone to your liking before you put the circuit into its container. The pitch is adjusted by changing the value of the resistor marked R on the schematic.

PREVIEW

Next session we return to power supplies. We will be looking at microprocessor power supplies and multiple voltage supplies, and protection circuits that should be included to prevent loss of

expensive microprocessor chips and memories. For one experiment we'll need an SCR (triac). Get an inexpensive one for the experiment. And we'll have another 555 circuit using it as a *touch control*.

No supplier has been contacted about the few parts needed for the next session. You should already have everything, except perhaps the SCR. The other materials should be scrounged up somewhere or purchased locally, as they will be too heavy to mail. ■

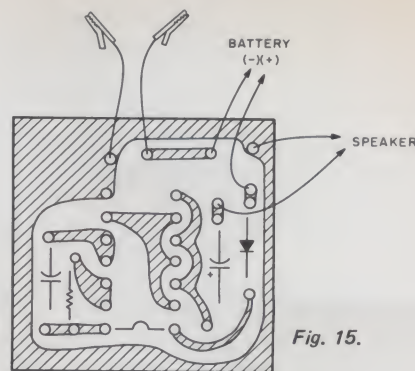


Fig. 15.

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Digital Group

MAXI-Basic

... how come ?

Charles P. Howerton, President
Digital Group Software Systems
PO Box 1086
Arvada CO 80001

On a bright cold day in mid-December The Digital Group, in conjunction with Digital Group Software Systems, mailed 15,000 flyers announcing our long and not-so-patiently-awaited full-sized BASIC. Within 48 hours orders began to flow in from Digital Group owners and users from Maine to Alaska, Florida to California, and Europe to Australia.

Oh, happy day! We thought! We had prepackaged cassettes and documentation in preparation and immediately went into a high speed shipping mode and tried to turn orders for MAXI-Basic around as quickly as possible (many were shipped the same day as the order was received). Needless to say we had expected a joyous elated response from the users and for the most part, that is what we received. Then the *bits* hit the *bus* and the phone began to ring and hasn't stopped since.

No one came right out and said "MAXI-Basic stinks" or "MAXI-Basic is no good" or any of a number of comments to which we could have responded with a raspberry and an invitation to

return it for a refund. Most of the callers asked "Why doesn't MAXI-Basic have this?" or "Why doesn't MAXI-Basic do that?"

We knew that the documentation left something to be desired, as is usually the case when a product is rushed to delivery to meet a recognized demand, and felt that the option to receive an upgraded version in the spring (for the Z-80 only) would fill this void. However, surprisingly, most of the complaints were not about the documentation, per se. We attempt to maintain a log of complaints so that future versions of products can be modified to incorporate fixes and suggested improvements. It wasn't very long before the MAXI-Basic log got out of hand and caused alarm bells to ring.

The question foremost in our minds was "Had we propagated a disaster?" In order to attempt to develop an answer to this question, we sat down with the MAXI-Basic log and began to analyze the reported problems (we call them *bitches*). The pattern which emerged initially was that there was no particular pattern to the comments. There were, of course, several clusters principally in the areas of the lack of pre-

defined inverse trigonometric functions and misunderstandings in how to use the string manipulation resources but these were easily handled by explanations of the strings and suggestions that user-defined inverse functions, where required, were more cost effective in memory utilization than using up space carrying them around when they are not universally used. The balance of the commentary had no pattern at all. They are typified by the following:

— Why didn't you use PEEK and POKE like MITS instead of EXAM(ine) and FILL?

— Why is it I have to specify the starting and ending characters of a substring instead of the starting character and the length?

— I want to be able to specify the precision of each variable. Do you plan to have this in Version 2?

— Did you know that some BASICs allow you to go back and forth from string values to numeric values just using the LET (which can be implied) rather than using functions like you guys do?

— Are you going to have the DO with indentation instead of or in addition to the FOR NEXT as on the Darned Expensive Computer QEQ-18-T?

— I have been working with the HAL-250 200K Interactive Time-shared BASIC and it has the WHEN-MAYBE command. Do you plan to add this facility?

— Why did you use SCR instead of NEW? I blew my opus magnus the other night because of that!

— and on, and on . . .

A hundred bucks worth of long distance calls and much celebration finally revealed the cause of this problem:

1. None of the complainants were programmers by profession.

2. Almost all had used some version of BASIC in school and were accustomed to using the one or two versions of the language with which they had worked.

3. From personal experience, there are over 30 currently available *official* versions of BASIC on every size machine from micros through minis to really-biggies.

4. There are several hundred books on the BASIC language with each professing to be the best description.

5. Some manufacturers have made available source listings of their BASIC Interpreter to users (especially schools and research institutions) and these users have highly modified the BASIC for their own purposes and then taught the use of the modified version as if it were the *official* version. There are probably several thousand variants of the original Dartmouth BASIC floating around out there in the world.

6. Use of the WHEN-MAYBE construct in conjunction with a little old-fashioned permutations and combinations mathematics using MAXI-Basic and the MARK-I Human Logic System suggests *sometimes* that it is highly possible that several million casual users could each have a slightly different concept of BASIC, what it contains and how to use it.

The professional programmer, when handed some documentation on a new version of a language with which he or she may or may not be familiar, usually sits down with a coding form and exercises the language until a good level of proficiency is achieved. While there may be an occasional grumble about one thing or another with respect to the version being used, there is a job to do and one way or the other, it gets done.

The systems programmer who is given the job of writing a BASIC Interpreter creates a work of art which is his or her understanding of what BASIC is and how it works (sometimes good, sometimes bad). Since there has not been a *standard* definition of BASIC* available until now, most BASICs were implemented to fit the particular piece of hardware

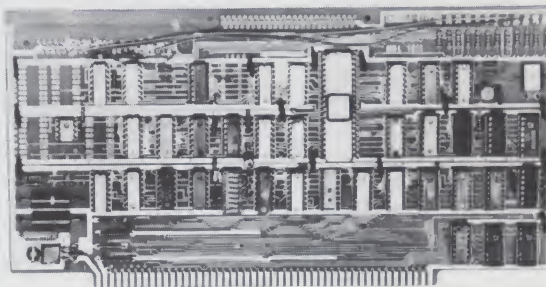
for which they were being written. If and when a standard definition of the BASIC language is accepted by the computer community, it should be remembered that such standards are minimum standards and that each manufacturer/implementor will embellish its version with features which it feels best sets off its hardware or software talent. There are probably 50 versions *each* of COBOL and FORTRAN which are minimally compatible at the *minimum standard* level. IBM alone has at least four variants of the COBOL language.

When one takes into account all of the foregoing, it would be relatively easy to come to the conclusion that, like religion and politics, *BASIC is a personal thing* that reflects your personal training and experience with the version with which you are most familiar.

As for MAXI-Basic; MAXI-Basic is MAXI-Basic. Try it! You'll like it!! ■

*A Standard for BASIC is in the works and will be released in 1977.

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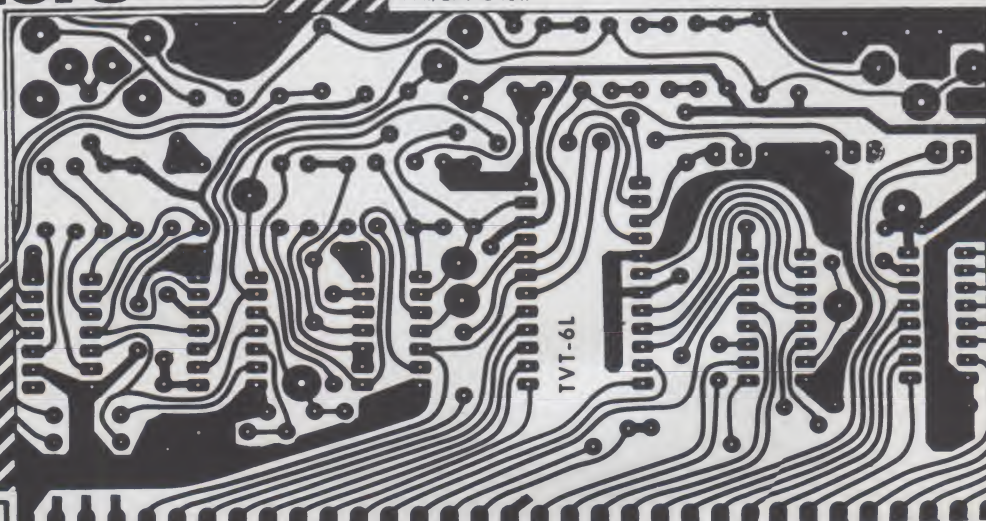
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C31

Utilize ASCII Control Codes !

... for cursor control, etc.

Richard Wright
676 Coe
Tiffin OH 44883

If you've ever looked at an ASCII chart, you may have noticed 32 control functions. Most stand-alone terminals use these for house-keeping, like Space and Line-feed (SP & LF). Even if your system uses 12 of these, that still leaves 20 that can be used for outside world commands or cursor control. Read on and I'll show you how to do it — cheap!

First look at Chart 1, column 1 and pick out the control functions your

system already uses. Column 2 shows my TV II, 8K BASIC, and cassette interface controls. As you can see in column 3, this left me 18 functions to use as I wish. Column 4 is the hex call-ups and column 5 the decimal call-ups for BASIC.

Hardware

The ASCII code for control characters differs from alphanumeric only by the logic level of bits 6 and 7. All we need to test for the

presence of a control character is to determine if *both* bits 6 and 7 are logic low. The TV II tests bits 6 and 7 internally with a 2-input NAND gate, IC 32(c). The output of this gate is available at pin 6 of cursor control board connector J3. The rest of the ASCII code bits 1, 2, 3, 4, 5 are available at cursor control board connector J4, pins 9, 8, 7, 6, 5 respectively. Solder a wire to each of these points on the cursor control board and a wire to ground at

Control	Control Already Used	Terminal Control Added	Hex Callups	BASIC Callups	Direct KBD Control
NUL			00	----	----
SOH			01	CHR\$(1)	CTRL A
STX			02	CHR\$(2)	CTRL B
ETX			03	CHR\$(3)	CTRL C
EOT			04	CHR\$(4)	CTRL D
END			05	CHR\$(5)	CTRL E
ACK			06	CHR\$(6)	CTRL F
BEL			07	CHR\$(7)	CTRL G
BS			08	CHR\$(8)	CTRL H
HT			09	CHR\$(9)	CTRL I
LF	LINE FEED		0A	CHR\$(10)	CTRL J
VT		WARNING LIGHT	0B	CHR\$(11)	CTRL K
FF		WARNING BUZZER	0C	CHR\$(12)	CTRL L
CR	CARRIAGE RETURN		0D	CHR\$(13)	CTRL M
SO		CURSOR LEFT	0E	CHR\$(14)	CTRL N
SI	BACK SPACE		0F	CHR\$(15)	CTRL O
DLE	CURSOR HOME UP		10	CHR\$(16)	CTRL P
DC1	CASSETTE				
DC2	PLAYBACK ON		11	CHR\$(17)	CTRL Q
DC3	CASSETTE				
DC4	RECORD ON		12	CHR\$(18)	CTRL R
DC5	CASSETTE				
DC6	PLAYBACK OFF		13	CHR\$(19)	CTRL S
DC7	CASSETTE				
DC8	RECORD OFF		14	CHR\$(20)	CTRL T
NAK	ERASE END				
SYN	OF LINE		15	CHR\$(21)	CTRL U
ETB	ERASE END				
CAN	OF FRAME		16	CHR\$(22)	CTRL V
EM	CURSOR RIGHT		17	CHR\$(23)	CTRL W
SUB	DELETE		18	CHR\$(24)	CTRL X
ESC		CURSOR UP	19	CHR\$(25)	CTRL Y
		CURSOR DOWN	1A	CHR\$(26)	CTRL Z
		HARD COPY			
		ON & OFF	1B	CHR\$(27)	CTRL [
FS		CURSOR ON	1C	CHR\$(28)	
GS		CURSOR OFF	1D	CHR\$(29)	CTRL]
RS		PAGE 1	1E	CHR\$(30)	CTRL ^
US		PAGE 2	1F	CHR\$(31)	CTRL _
SP	SPACE		20	CHR\$(32)	SPACE BAR

Chart 1. ASCII control character chart.

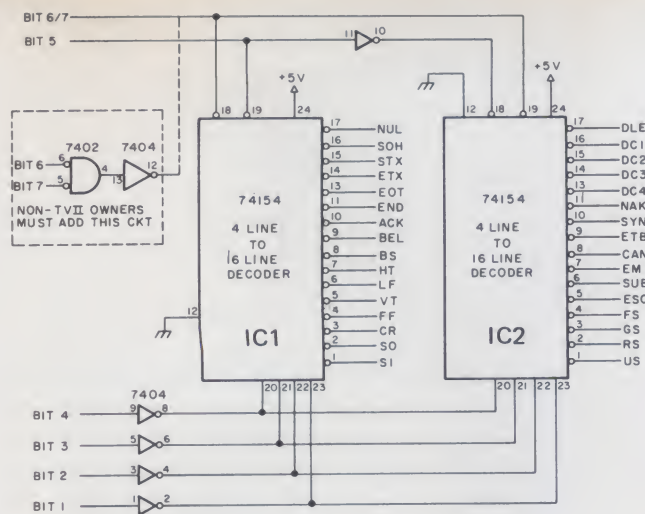


Fig. 1. 32 control character decoder with buffered inputs and TTL logic level outputs (output is unstrobed).

pin 2 of J4. Now, bring these wires to the outside world and we are ready to experiment.

For the following experimentation, a solderless breadboard is invaluable. To test these circuits it will be easiest to write a small program to sequentially call up each of the ASCII control characters. The program will depend on the CPU architecture of your machine. In BASIC the program might look like this:

```
10 FOR X = 1 TO 31
20 PRINT X; CHR$(X)
30 NEXT X
40 GOTO 10
```

To prevent upsetting normal operation of my TV II, I felt it necessary to buffer all bit lines except 6/7. The first circuit I tried is shown in Fig. 1. IC 1 and IC 2 are 4-line-to-16-line decoders. The logic level of bit 5 determines which decoder will be enabled. Control-character-recognition line 6/7 provides chip enable. The logic levels of bits 1 through 4 determine which decoder output will go low.

The circuit in Fig. 1 worked well but had one flaw. The decoder outputs were TTL logic levels. For some outside world commands 3.4 V and .2 V levels would have worked fine, but for cursor control I needed open-collector drivers. Rather

than add a resistor and transistor to each output, I decided to check the parts box ("junk box" is a vulgarity) for an alternative decoder. Southwest Technical Products used a 7445 on the cursor control board so I looked for those. Sure enough, I had a couple of dozen 7445s I'd taken off surplus boards with a propane torch.

The circuit in Fig. 2 is the result of my next experiment.

It's a 32 control character decoder with full input buffering and open collector output. This circuit can be used by any stand-alone terminal or keyboard utilizing 7-bit ASCII code.

The 7445s are BCD to decimal decoders operating in a 3-line-to-8-line mode. In this mode, pin 12 becomes a chip enable. As long as pin 12 remains high all of the eight lower outputs will remain open. Whenever pin 12 goes low one of the eight outputs will go low. Which one of the outputs will be determined by the logic levels of bits 1, 2, and 3? Bits 4 and 5 are decoded by the 3-input NAND gates (7410). These gates decide which 7445 will be enabled. Now, for every control character recognition decoded from bits 6 and 7, the one-shot formed by IC 5 will be triggered. The output of the one-shot is a slightly delayed, short-lived pulse. The enabling strobe from the one-shot is routed to one of the 7445s by way of the 3-input NAND gates and one of the 32 decoder outputs goes momentarily low.

The one-shot circuit has been optimized for the TV II.

If for any reason you find it necessary to adjust this circuit, I'd suggest leaving R1 at 1k and adjust the value of C1 for delay or C2 for pulse width. In any case, C1 and C2 should have a 10% or better tolerance.

The TV II already has eight of the control characters decoded by the cursor control board, so portions of Fig. 2 would be redundant. Fig. 3 is a modified version I use in my TV II terminal. If you breadboard the circuits in Figs. 2 or 3, you will find the strobe output goes by so quickly a static logic probe won't detect it. You will have to use a scope or a pulse-catcher circuit like the one in Fig. 4.

Software Cursor Control

Once you have decoded these commands, what do you do? Well, that depends on personal needs. As Fig. 3 indicates, I use a bunch of them to provide full software cursor control. This allows me to get away from the restrictive, top-to-bottom/left-to-right format of the TV II system as much as possible. Consider how nice it would be to print anywhere on the

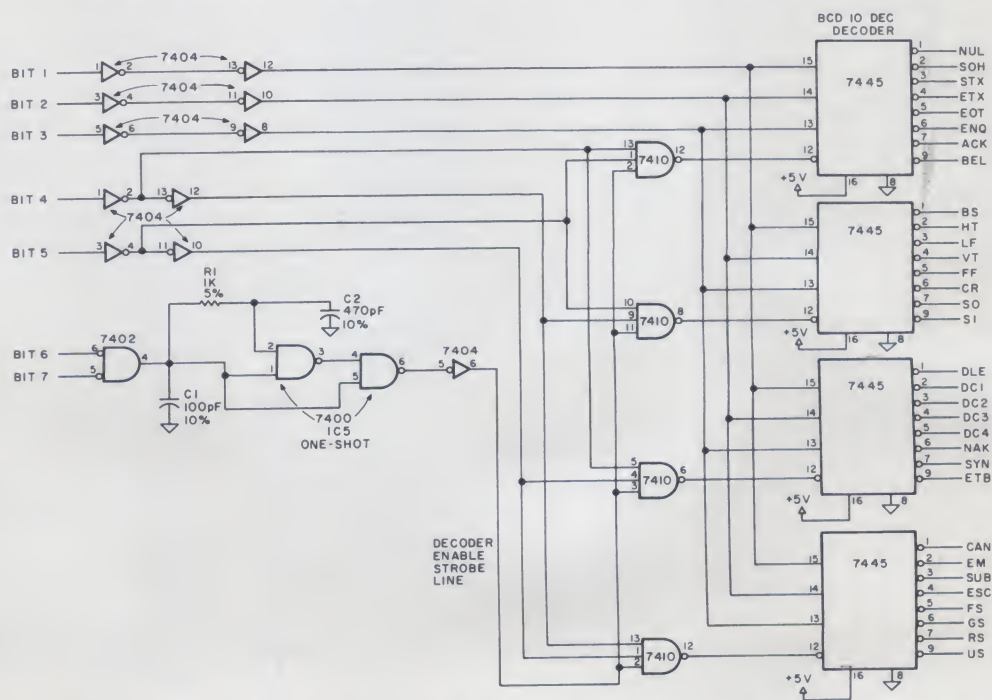


Fig. 2. 32 control character decoder with buffered inputs and 30 V, 80 mA open collector outputs (can be used with any 7-bit ASCII terminal).

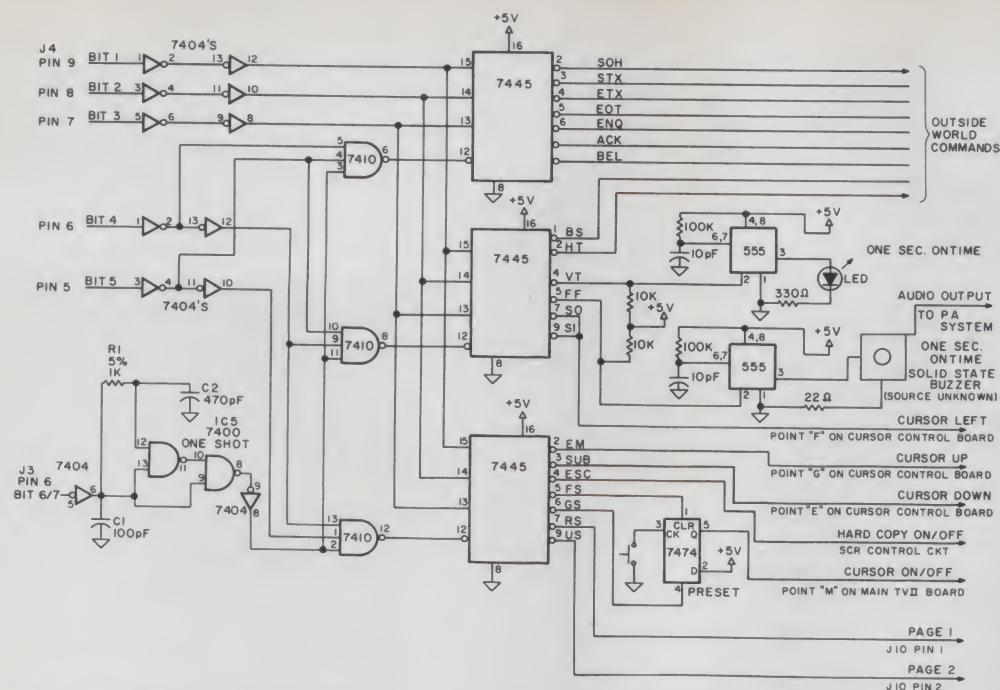


Fig. 3. Modified version of Fig. 2 used in TV II with cursor control board. Provides full computer cursor control and page select as well as outside world commands.

CRT anytime you wish. You can do this in BASIC with PRINT CHR\$(X) and FOR-NEXT loops.

In the TV II, many of the cursor control functions were diverted to control the AC-30 cassette interface. As Fig. 3 shows, to regain full cursor control and pick up software page-select, it's only necessary to connect the open collectors from our decoder to solder points provided on the cursor control board and J10. By using open collectors, local-manual control can be maintained with momentary contact switches. (I use re-labeled calculator keys.)

My KBD-5 keyboard has a nice, red, encoded ESC key which is used absolutely no-

where in the system. I eliminated this wasteful condition by dedicating the ESC key to hard-copy on/off control. One half of a 7474 D-type flip-flop is used for cursor-on/off control.

I should explain about the warning light and buzzer. One project I am currently involved in is the monitoring and automatic control of a commercial FM transmitter, so I added two warning devices within the terminal. The light flashes when the nominal transmitter parameters have been exceeded and the computer is taking corrective action. The buzzer sounds when the computer has corrected all it can and an operator must do something

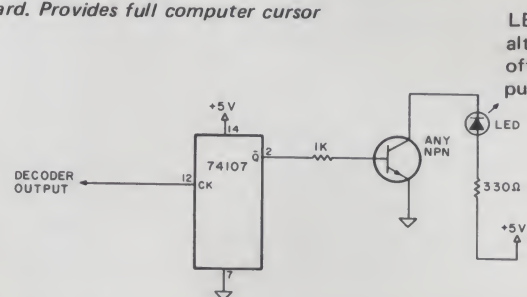


Fig. 4. Pulse catcher used to detect strobed outputs for testing Figs. 2 and 3.

within three minutes. I wish I could tell you more about the buzzer unit, but all I know is that it takes 50 mA at 5 volts to operate. I bought four at the Dayton Hamvention for 50¢ each. (This application gives you an idea of one of the many areas this circuit can be used in.)

Once I verified the operation of Fig. 3 on the bread-

board I point-to-point soldered it together on a circuit board. I then wired and mounted a double 22-pin edge connector inside the aluminum bud-box housing my terminal. A chassis mounted 15-pin D subminiature connector terminates outside world commands.

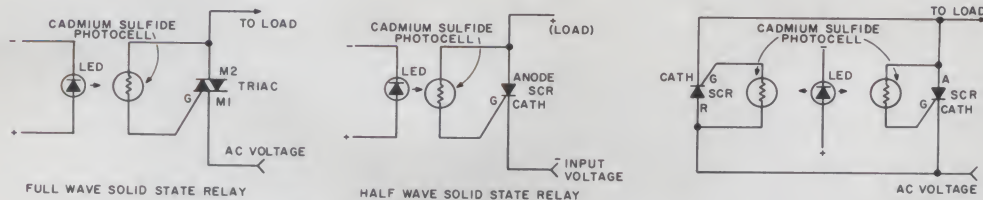
Outside World Commands

Cadmium sulfide photocells are easily obtainable at your local Radio Shack, cheap! By placing an LED near the face of a cadmium sulfide photocell you have constructed your own optical coupler with isolation characteristics equal to or better than commercial units.

CD-S photocells have some advantages over solid state

junction types, which make them very easy to use with silicon-controlled rectifiers (SCRs) and TRIACs. First, CD-Ss can control a fairly large amount of current, but more important, they are photo-resistive, which means they control positive and negative-going control voltages equally well.

Without delving too deeply into thyristor theory, we can say that the circuits in Fig. 5 act like light-controlled solid state relays. In each circuit, when light from the LED falls on the CD-S photocell, the resistance falls to a relatively low value. This low resistance will allow a control voltage, going in the correct direction and sufficiently large, to be applied to the gate of the TRIAC or SCR to turn it on. The net effect is



In dc ckts SCR latches closed when light falls on photocell. Voltage across SCR must fall to zero before SCR will open.

You can build your own full wave solid state relay with back-to-back SCRs.

Fig. 5. Basic control circuits can be thought of as light controlled solid state relays.

similar to the closing of a switch. When light no longer falls on the photocell the TRIAC or SCR will remain on, until the voltage falls near zero. This happens automatically 120 times a second in an ac circuit.

In a dc circuit some method of dropping the voltage across the SCR or TRIAC to zero will have to be provided. A switch, parallel to or in series with the SCR or TRIAC, will do nicely. By the way, the brushes in a dc motor or a "universal" motor will interrupt the circuit automatically.

There is one limitation to this idea. The spectral response time of cadmium sulfide photocells is not much faster than the human eye. This means the LED must be on or off for about 1/30 second before the photocell responds. Fortunately, for on/off control this is not much of a limitation.

Fig. 6 demonstrates various ways I use our solid state relays to control ac and dc motors, solenoids, transmitters, almost anything! You can alternately turn something on and off using a single control command to the CLK input of the 7476 flip-flop in Fig. 6a. Two separate control commands can be connected to the preset and reset for individual on/off control. Just decide what you want to control, then wire the TRIAC directly across the power switch and let your computer do it for you.

Fig. 6b can be used to turn an ac or interrupted dc circuit on for a short time. The value of C4 and R4 determine the on-time. I use Fig. 6b to control a small dc motor to raise and lower transmitter power in small increments.

One word of caution — our home built opto-coupler is very sensitive. If exposed to any ambient light, the control

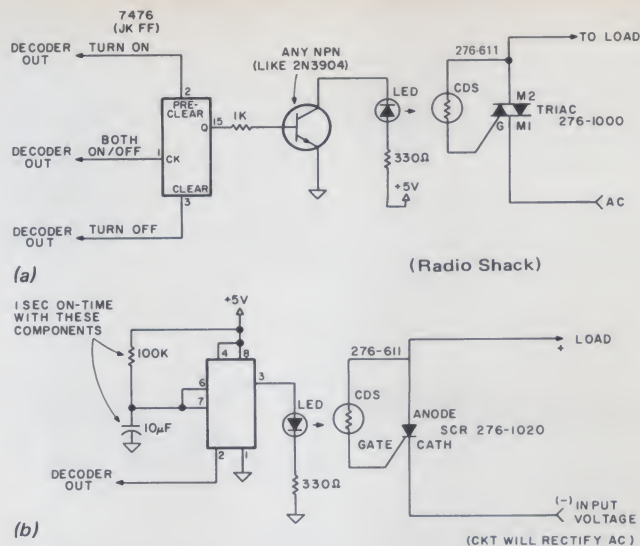


Fig. 6. Variations of these circuits are used to control outside world devices.

device will turn full on. In most applications a light shield around the LED and photocell will be necessary.

In case you haven't noticed, we've provided lots of outside world control without adding another port

to our systems. A special bonus for BASIC freaks is that you don't have to PEEK and POKE around or go to user programs to turn something on or off. Just PRINT CHR\$(27) ... oops ... that turned off my Selectric! ■

SAVE! SAVE! SAVE!

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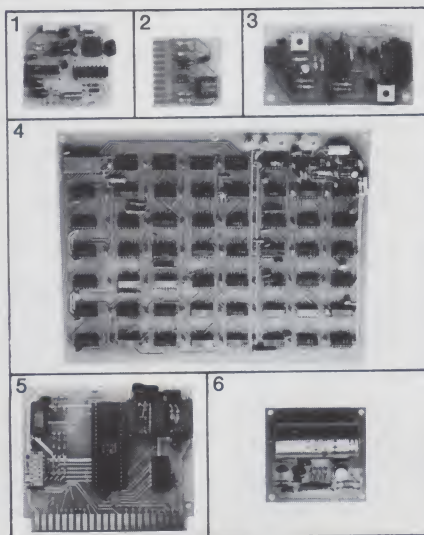
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E21

Dedicated Controllers

... there is money to be made

Michael J. Myers
Ann Arbor MI 48105

Mike's article demonstrates that there are money-making opportunities out there in dedicated controller applications. And ... the hobbyist should be taking advantage of the situation and doing something about it. His article should stimulate some thought along these lines, and if nothing else, get you busy with some experimenting so you'll be ready for that money-maker when it comes along. — John.

Are you tired of playing games? Try some machine language programming on your 8080, 6800, or 6502 and make some money with it! Let me start my story at the beginning.

About two years ago I was approached to design a process controller on a consulting basis for a small company producing special film processors. They don't have enough electronics work to warrant having an electronics shop, or even a full-time technician.

The problem was to sequence a number of valves and pumps to control a

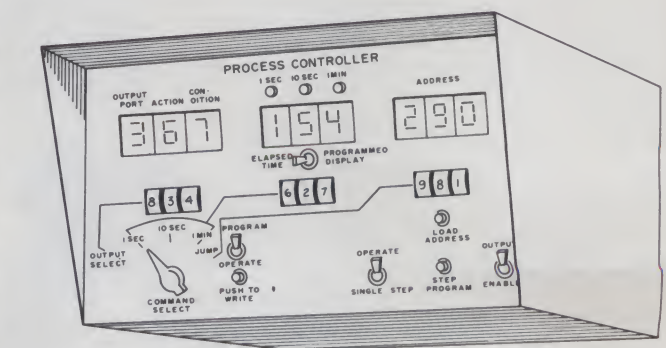


Fig. 1. Process controller front panel.

custom film processor. The process is rather slow, taking a period of up to an hour. The customer needed a programmable sequencer that

could cause the valves and pumps to operate in a preprogrammed time sequence. The programming was to be straightforward, as the pro-

cess to be run might change frequently. Capability to control four or five processors simultaneously was also required.

The First, Non-micro Version

At the start of the project we looked at microprocessors (the 8008 was just getting into general use), and on the basis of my experience with digital logic and inexperience with microcomputers, I decided to go the hard-wired logic route. The description of this first unit, which follows, is presented for the purpose of illustrating the differences in complexity and ease between the hard-wired and microcomputer approach. The hard-wired version is still in daily use by the customer and operating faithfully.

I chose CMOS logic and memory so battery backup could be provided. The memory capacity is 256 16-bit words. Since most of the users are not familiar with hexadecimal notation, and thumbwheel switches are available in Binary-Coded Decimal (BCD), the words are divided into four BCD digits. There are three types of instructions, with variations on one of them: Fig. 1 is an illustration of the controller front panel.

A Select instruction is identified by the first digit, as are the others. The second digit identifies one of ten output ports. Each output is a 4-bit latched type. The third digit specifies the output to be present at the port (a 9 specifies the 4 bits to be 1001, etc.). The last digit of a select instruction specifies one of three conditions. Zero means "end this step at the programmed time." The digit 1 indicates a wait for a condition to be present, even if the programmed time is reached (used, for example, in a wash step in which wash is continued until the impurity of discharge water reaches a low level, measured by its conductivity). The number 2 means "proceed on an ex-

ternal signal", even if the programmed time has not yet been reached.

The second type of command is a time instruction. The first digit indicates the time units to be counted; seconds, ten seconds, or minutes. The last three digits indicate how many intervals are to be counted. For example, the code for ten seconds, followed by 036, would indicate a time of 360 seconds, or six minutes, during which to hold the output specified in the select instruction.

The third type of instruction is a jump, consisting of the jump code and a three-digit address to which to jump.

Because programming takes some time, and some of the sequences are used frequently, provision is made for ten subroutines stored in PROM. Each subroutine is thirty-two words long and is stored in a pair of 8223 fusible link programmable memory chips. These are accessed by jumping to addresses 300 to 309. LED displays are provided for current memory location, programmed time for this step, elapsed time for this step, and the output selected by the select code previous to the current time instruction.

As the project developed, interfaces were designed to drive nine solenoid valves and three pumps. Each interface uses two output ports; one for the valve information and one for the pumps. Valves operate one at a time, and are specified by one decimal digit (zero is an all off code). The three pumps each have a bit assigned to indicate their status, either on or off, and therefore may operate independently.

The finished programmer has ten different printed circuit card designs, and eighteen cards total. There are about 200 CMOS and TTL integrated circuits. It took two months of evenings and two solid weekends to wire it, and about as long to

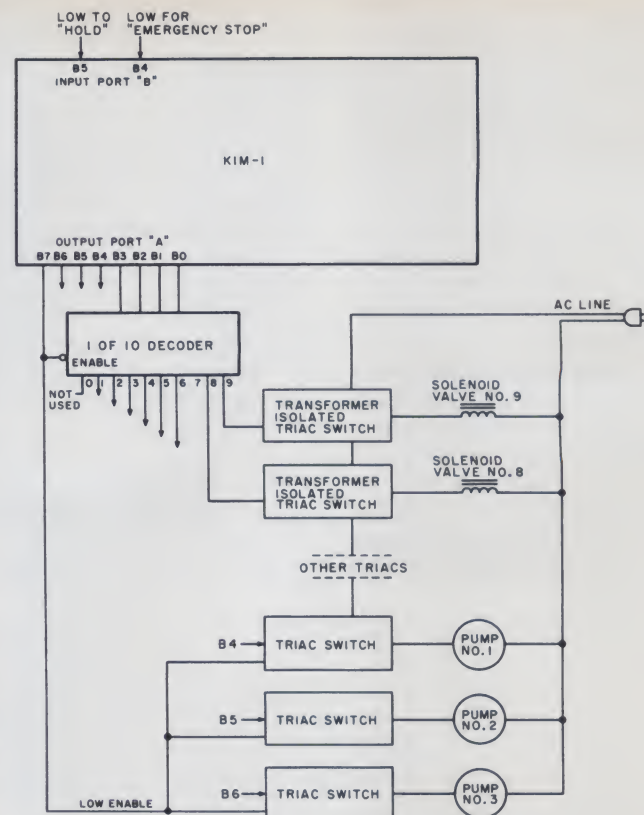


Fig. 2. KIM-based process controller block diagram.

get it all debugged. It was delivered in January, 1976, and has operated since with no failures.

Recently I received a call from the customer asking about more programmers. We discussed a simpler version, able to drive only one processor, and the possibility of a duplicate of the original.

Calling on KIM for the 2nd Version

I have been eyeing the growing use of microcomputers for some time, and was beginning to feel that if I didn't get some hands-on experience with one, I would soon be obsolete. I went to the local computer store and came home with a KIM-1 board.

My previous experience in programming was essentially having written a few programs for an HP-65 programmable calculator. I eagerly started reading the MOS Technology programming manual and KIM-1 user manual, which gives a sample program and instructions for

using the tape cassette interface and the self-contained hex keyboard. After a few puzzles things started to make sense, and I was able to do some simple operations, like add two two-digit numbers and store the results in memory.

The KIM interval timer looked like a natural for making a clock program, so I started on one.

I could see that this machine could easily do the sequencer job and immediately wrote my customer asking for a purchase order for some hours of my time to study the application of KIM for his use and to come up with some operating programs. Figuring that this was as good a way as any to learn the KIM, I started programming.

After a week of evenings I had a program that went through a table of data containing desired output conditions and times in a fixed repeated four-word format of: 1. output condition; 2. hours; 3. minutes; 4. seconds.

I connected some LEDs with buffers to an output port and verified operation of the program. A long look at the KIM monitor program (well documented in the user manual) gave me a clue as to how to display the time on the KIM. After a few false starts that was accomplished, and I wrote the customer again.

A few days later I received a call telling me that a purchase order was on the way for my time and one system to be assembled with connectors compatible with the interfaces, and a cassette recorder checked for compatibility with KIM. He said,

"Fine on the program, but how hard would it be to incorporate the hold feature of the original unit? Also it would be nice to have a choice of going through the sequence once, or for a programmed number of times."

Back to the drawing board. Another couple of evenings and the following were incorporated. After the last desired step, program 00 to turn all outputs off. Then:

1. EE for unconditionally ending the program after one time through the sequence.
2. BB for branch to begin-

ning and continue to repeat the sequence until manually stopped.

3. BC for branch to the beginning counted. The count for the desired number of repeats to be placed in the next location. This count is decremented once each time through the sequence. When it reaches zero the operation terminates.

It occurred to me that the KIM tape load routine has two possible endings. When the tape loads correctly, the display indicates 0000XX; if there is an error, it displays FFFFXX. A look through the monitor listing shows that a jump to the appropriate addresses will cause either of these two actions. Any normal ending of the operation will leave the display showing 0000XX.

KIM's second input/output port uses pin B7 for the interval timer interrupt output, and pin B6 is not brought out (refer to Fig. 2). B5 therefore is now programmed to cause the program to hold at the end of a step, even though the time has elapsed, as long as B5 is held low. During this condition the display is blanked.

B4 is programmed as an emergency stop input when it is pulled low, for example, by a "machine jammed" signal from a limit switch. The sequence terminates and KIM displays FFFXX and sounds an alarm.

The KIM system has one bad habit: When in monitor mode or when power is first applied, all I/O lines revert to being inputs until otherwise instructed by the program. That sounds like a good idea except for one problem. There are pull up resistors, so all the inputs go high, looking like outputs that are on. Since only three bits are required to control three pumps, the last bit of output port A (B7) is used as a low enable. That is, it must be made low by the program to enable the interface outputs.

At this point I am reserving the B port bits 0-3 for the more complex multiple output interface unit. Bits 2-0 will select interface 0 to 7 and bit 3 will be a strobe to latch the data from the A outputs into the interface selected.

The Controller Software

Fig. 3 is a flowchart of the controller routines. The listings are shown in Program A. The data table started out to be all of page 2 of the KIM memory. I later found out how to increment my base address for the indirect, Y addressing, and added all of page 3 as well. A maximum of 127 steps and a terminating code may therefore be programmed.

Note that the times are total elapsed. The timer does not reset to zero at the end of the previous time interval. Also, the Initialize routine only reenters values that are changed as the program runs. Several constants must be set up for proper operation. These will be on the program cassette and so will not be of concern to the user. These locations and values are: HRL,00; MINL,40; SECL,40; INDLO,00. (The program listing has been verified by entering it by hand from the listing, and testing its operation.)

Program B is a sample of the programming required by the user to get data into the system during initialization. After this is done the first time it isn't necessary to go through these steps again because the program and this data are recorded on the cassette.

Some Closing Thoughts

This program might be of interest to anyone wanting to "run the house" on their computer. If, for example, the last step ends at 23:59:59, a 24 hour clock is set up. The BB instruction is used to keep it running.

Eight outputs are then available to: 1. Switch the thermostat between day and

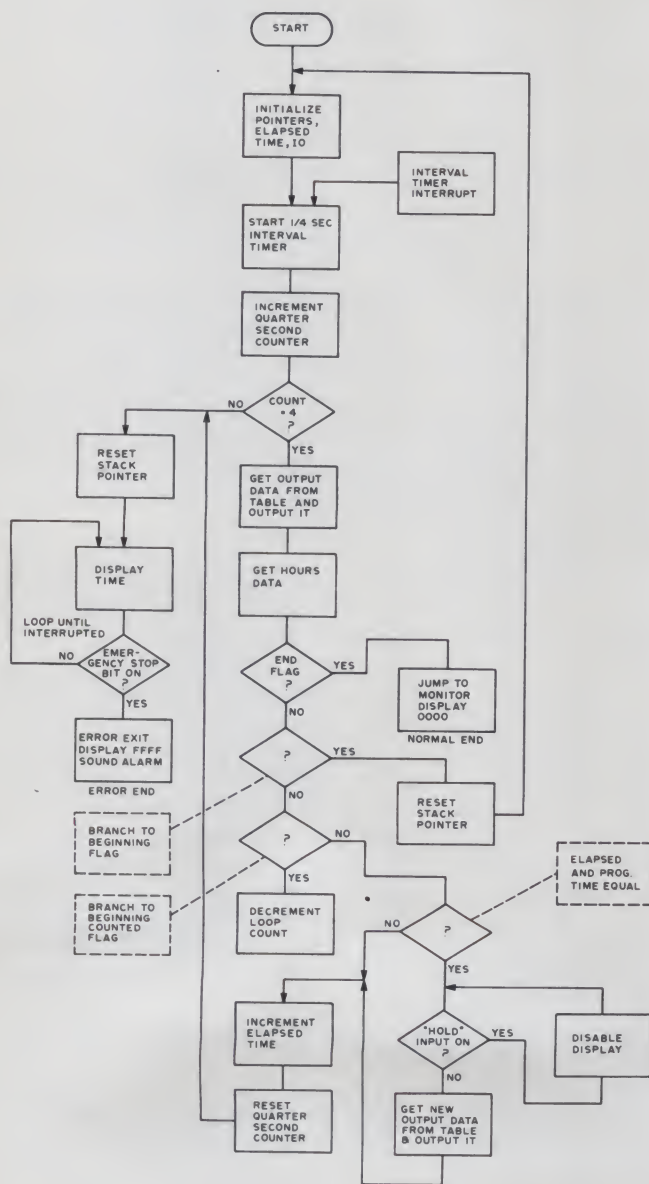


Fig. 3. Flowchart of controller program.

Addr	Data	Comment
0200	00	SET ALL OUTPUT BITS TO ZERO
0201	00	HOURS FOR THIS STEP =0
0202	01	MINUTES = 1
0203	00	SECONDS = 0
0204	0F	SET OUTPUT B7 TO B4 OFF, B3 TO B0 ON
0205	00	HOURS STILL ZERO
0206	02	MINUTES =2
0207	00	SECONDS =0
0208	F0	SET OUTPUT B7 TO B4 ON AND B3 TO B0 OFF
0209	00	HOURS = 0
020A	03	MINUTES = 3
020B	15	SECONDS = 15
020C	00	OUTPUTS ALL OFF
020D	BC	START OVER AGAIN (REPLACES HOURS DATA)
020E	09	COUNT 9 TIMES THROUGH, THEN STOP

Program B. Sample user program to sequence outputs.

night modes; 2. Turn on the coffee pot in the morning; 3. Turn on the radio, alarm, tape player, etc.; 4. Control the yard or front porch light; 5. Control a night light; 6. Control an attic fan, shutting it off at an appropriate time late at night; 7. Control lights around the house in a random-looking manner while you are away. You can use a 96 hour cycle and have the lighting pattern repeat every four days; 8. Program the TV to shut off at a predetermined time. I'm certain you can think up others.

I would like to emphasize a few points. I now have no I/O device other than the KIM display and hex keyboard. My system consists of a KIM board and a power supply. Yes, it did get to be a pain to reenter a couple of

hundred hex digits with the keyboard just to add a CLD instruction near the top of the program, but it's really not all that bad.

The original hard-wired programmer cost my customer \$5000, plus a trip to the plant for installation and training. This time he will get a packaged KIM-1 system, a cassette recorder/player, several cassettes (each a prerecorded copy of the operating portion of the program), a complete program listing, and operating instructions for recording his end program and data on a cassette. When the same process is to be run, he only has to load from a cassette. This convenience eliminates the need for a subroutine in PROM. Total cost this time will be a one-time charge of \$600 for the pro-

gram and \$450 for the packaged and tested KIM system. Additional units will cost \$450 each. Additional programmed features as they come to the customer's mind will be supplied on the basis of an hourly charge for programming.

What would a duplicate of the original cost? I already have the PC board negatives and extensive wiring lists and corrected schematics, so of course there would be a reduction in cost. The labor, however, is a very large item, and I would have to charge \$3000 or so.

At this point, you are saying, "Great! Here's a guy that has been designing circuits for a long time telling us how easy it is to make money with a computer. I'm no engineer. How can I do it?"

Frankly I think it is easier than any of us imagine. There are lots of companies that are not in the electronics business (believe it or not). Some of these are not in a position to be able to support full-time electronics people. The microcomputer field is moving so fast that most companies don't yet realize what can be done. Spread the word. Go find an application and go to it! "Where do I begin to look?" you say. Contact a nearby small university or college. Likely customers are people doing research in chemistry, psychology, physiology, music schools, language departments, small medical facilities.

Go talk to some of these people. Arrange a brainstorming session. Listen to what they need. Tell them what can be done. Maybe you'll have to work free the first time around, but you don't get paid for playing games either. And in my opinion it is just as much fun! Who knows, maybe you (or I) will find an application that will lead to a whole new business ... opening up a whole new area for the application of microprocessor technology. The time is right now. The applications far exceed the number of people with the knowledge to make them work. ■

Program A. Listing for process controller program (continued on following page).

Addr	B1	B2	B3	Label	Oper.	Operand	Comment
000A	A9	00		INIT	LDA	#00	THESE INSTRUCTIONS RESET CLOCK TO ZERO
000C	85	01			STA	HR	
000E	85	02			STA	MIN	
0010	85	03			STA	SEC	INITIALIZES Y TO START OF DATA TABLE
0012	85	09			STA	YBUF	
0014	8D	00	17		STA	PAD	
0017	8D	FF	17		STA	IRQHI	SET UP HI BYTE OF INTERRUPT VECTOR
001A	A9	02			LDA	#02	HI BYTE OF INDIRECT BASE ADDRESS
001C	85	08			STA	INDHI	
001E	A9	10			LDA	#10	
0020	85	00			STA	CNT	INITIALIZE QUARTER SECOND COUNTER
0022	A9	2C			LDA	#2C	LO BYTE OF INTERRUPT VECTOR
0024	8D	FE	17		STA	IRQLO	
0027	A9	FF			LDA	#FF	
0029	8D	01	17		STA	PADD	DEFINES OUTPUT PORT A AS OUTPUT
002C	A9	17		INTR	LDA	#17	INTERRUPT TO HERE
002E	18			CORR	CLC		THIS IS A TIMING LOOP TO CORRECT THE TIME
002F	E9	00			SBC	#00	PER INTERRUPT TO BE 1/4 SECOND
0031	D0	FB			BNE	CORR	COUNT FOR INTERVAL TIMER (COUNTS 244 X 1024 MICROSECONDS, 144 SHORT, LOOP CORRECTS)
0033	A9	F4			LDA	#F4	
0035	8D	0F	17		STA	TIMER	
0038	06	00			ASL	CNT	SHIFT CNT LEFT
003A	90	75			BCC	INT6	BRANCH IF NOT FOUR COUNTS
003C	A4	09			LDY	YBUF	GET FIRST OUTPUT DATA FROM TABLE
003E	B1	07			LDA	IND,Y	

0040	8D	00	17		STA	PAD	APPLY DATA TO OUTPUT PORT
0043	C8				INY		
0044	B1	07			LDA	IND,Y	GET HOURS DATA, TIME TO END THIS STEP
0046	C9	EE			CMP	#\$EE	TEST FOR END PROGRAM FLAG
0048	F0	12			BEQ	END	IF EQUAL GO TO END ROUTINE
004A	C9	BB			CMP	#\$BB	TEST FOR "BRANCH TO BEGINNING" FLAG
004C	F0	11			BEQ	RESTART	
004E	C9	BC			CMP	#\$BC	TEST FOR "BR. TO BEGIN., COUNTED" FLAG
0050	D0	13			BNE	CHR	IF NOT COMPARE HOUR
0052	C8				INY		
0053	B1	07			LDA	IND,Y	GET LOOP COUNT FOLLOWING BC FLAG
0055	18				CLC		SET BORROW FLAG
0056	E9	00			SBC	#\$00	SUBTRACT 00 WITH BORROW (SUBTRACT 1)
0058	91	07			STA	IND,Y	RETURN DECREMENTED LOOP COUNT TO BC FLAG+1
005A	D0	03			BNE	RESTART	BRANCH IF LOOP COUNT NOT ZERO
005C	4C	25	19	END	JMP	MONITOR	TAPE LOAD ROUTINE NORMAL EXIT, DISP. 0000XX
005F	A2	FF		RESTART	LDX	#\$FF	RESET STACK POINTER, ADVANCED BY INTERRUPT
0061	9A				TXS		SUBSTITUTES FOR RTS INSTRUCTION
0062	4C	0A	00		JMP	INIT	GO TO INITIALIZE (NORMAL PROGRAM START POINT)
0065	C5	01		CHR	CMP	HR	COMPARE PROGRAMMED TO ELAPSED HOUR
0067	F0	03			BEQ	CMIN	IF HOURS EQUAL CHECK MINUTES
0069	4C	9A	00		JMP	INCR	IF NOT, INCREMENT CLOCK
006C	C8			CMIN	INY		
006D	B1	07			LDA	IND,Y	GET MINUTES DATA
006F	C5	02			CMP	MIN	COMPARE MINUTES PROGRAMMED TO ELAPSED
0071	F0	03			BEQ	SEC	IF EQUAL CHECK SECONDS
0073	4C	9A	00		JMP	INCR	IF NOT, INCREMENT CLOCK
0076	C8			CSEC	INY		
0077	B1	07			LDA	IND,Y	GET SECONDS DATA
0079	C5	03			CMP	SEC	COMPARE PROGRAMMED TO ELAPSED
007B	F0	03			BEQ	ADVANCE	IF EQUAL GET NEW OUTPUT DATA
007D	4C	9A	00		JMP	INCR	IF NOT, INCREMENT CLOCK
0080	C8			ADVANCE	INY		
0081	C0	00			CPY	#\$00	Y HAS CARRIED IF ZERO
0083	D0	02			BNE	HOLD	IF NO CARRY GO TO HOLD
0085	E6	08			INC	INDHI	IF CARRY INCREMENT INDHI (ADVANCE PAGE)
0087	A9	00		HOLD	LDA	#\$00	
0089	8D	42	17		STA	PBD(KIM)	DISABLES DISPLAY IN HOLD MODE
008C	A9	20		LOP	LDA	#\$20	MASK TO TEST PBD 5
008E	2C	02	17		BIT	PBD	TEST PBD 5
0091	F0	F9			BEQ	LOP	IF LOW, HOLD IN LOOP
0093	B1	07			LDA	IND,Y	IF NOT, GET NEXT OUTPUT DATA
0095	8D	00	17		STA	PAD	UPDATE OUTPUT
0098	84	09			STY	YBUF	SAVE Y
009A	A2	03		INCR	LDX	#\$03	THESE STEPS ADVANCE CLOCK 1 SECOND
009C	A9	00			LDA	#\$00	
009E	F8				SED		
009F	38			INCR1	SEC		
00A0	75	00			ADC	HR-1, X	ADD 1 TO SEC (FIRST LOOP) MIN (2ND) HR (3RD)
00A2	95	00			STA	HR-1, X	PUT BACK IN PROPER CLOCK LOCATION
00A4	75	03			ADC	HRL-1, X	ADD SECL (1ST LP) MINL (2ND) HRL (3RD)
00A6	90	05			BCC	INT4	IF NO CARRY, DONE INCR CLOCK, LEAVE LOOP
00A8	95	00			STA	HR-1, X	IF CARRY, SEC=0 (1ST) MIN=0 (2ND)
00AA	CA				DEX		
00AB	D0	F2			BNE	INCR1	CLOCK INCREMENT LOOP AGAIN
00AD	A9	10		INT4	LDA	#\$10	RELOAD 4 COUNTER FOR INTERRUPTS
00AF	85	00			STA	CNT	
00B1	A2	FF		INT6	LDX	#\$FF	RESET STACK POINTER, OTHERWISE WOULD REQUIRE
00B3	9A				TXS		RTI INSTRUCTION
00B4	D8				CLD		CLEAR DECIMAL MODE
00B5	58				CLI		CLR. INTERRUPT MASK
00B6	A5	01		DPLY	LDA	HR	START DISPLAY ROUTINE
00B8	85	FB			STA	FB	MONITOR BUFFER FOR LEFT TWO DIGITS
00BA	A5	02			LDA	MIN	
00BC	85	FA			STA	FA	MIDDLE TWO DIGITS
00BE	A5	03			LDA	SEC	
00C0	85	F9			STA	F9	RIGHT TWO DIGITS
00C2	20	1F	1F		JSR	SCANDS	MONITOR SUBROUTINE, SCAN DISPLAY
00C5	A9	10			LDA	#\$10	MASK TO TEST PB4
00C7	2C	02	17		BIT	PBD	BIT TEST PB4
00CA	F0	03			BEQ	STOP	IF PB4 LO, GO TO ERROR STOP
00CC	4C	B6	00		JMP	DPLY	RETURN TO DISPLAY LOOP UNTIL INTERRUPTED
00CF	A9	00		STOP	LDA	#\$00	
00D1	8D	00	17		STA	PAD	DISABLE OUTPUT
00D4	4C	29	19		JMP	MONITOR	TAPE LOAD ROUTINE, ERROR EXIT, DISP. FFFFXX

Sequencer Program
Locations Used
Comment

Address	Label	
0000	CNT	FOUR COUNTER, COUNTS QUARTER SECONDS
0001	HR	CLOCK CURRENT TIME IN HOURS
0002	MIN	CLOCK CURRENT TIME IN MINUTES
0003	SEC	CLOCK CURRENT TIME IN SECONDS
0004	HRL	HOUR LIMIT; 100+LIMIT CAUSES CARRY
0005	MINL	MINUTE LIMIT INITIALIZED TO 40
0006	SECL	SECOND LIMIT, INITIALIZED TO 40
0007	INDLO	LO BYTE BASE ADDRESS FOR IND,Y ADDRESSING
0008	INDHI	HI BYTE BASE ADDRESS FOR IND,Y ADDRESSING
0009	YBUF	SAVE Y LOCATION

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MODE
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EPROMs
PROMs
MNEMONICS
ROMs
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S1

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Molly Oglesby
(90)

1. FORTY-FIVE DIVIDED BY NINE PLUS FIFTY-FOUR DIVIDED BY SIX = *Fourteen*

$$\frac{5}{9} + \frac{54}{6} = 14$$

2. THIRTY-SIX DIVIDED BY SIX PLUS NINE TIMES EIGHT = *Seventy-eight*

$$\frac{36}{6} + 9 \times 8 = 78$$

3. NINE DIVIDED BY NINE PLUS SIXTY-FOUR DIVIDED BY EIGHT = *Nine*

$$\frac{9}{9} + \frac{64}{8} = 9$$

4. EIGHT DIVIDED BY ONE PLUS SEVEN TIMES NINE = *Seventy-One*

$$\frac{8}{1} + 7 \times 9 = 71$$

5. TWELVE DIVIDED BY TWO PLUS FOUR TIMES THREE = *Eighteen*

$$\frac{12}{2} + 4 \times 3 = 18$$

6. SEVEN TIMES FOUR MINUS THREE TIMES FIVE = *Thirteen*

$$7 \times 4 - 3 \times 5 = 13$$

7. FIVE TIMES FIVE PLUS ONE TIMES NINE = *Thirty-four*

$$5 \times 5 + 1 \times 9 = 34$$

8. FIVE TIMES SIX PLUS EIGHT DIVIDED BY EIGHT = *Thirty-One*

$$5 \times 6 + \frac{8}{8} = 31$$

9. SEVEN TIMES NINE MINUS EIGHT DIVIDED BY TWO = *Fifty-Nine*

$$7 \times 9 - \frac{8}{2} = 59$$

10. FORTY-FIVE DIVIDED BY NINE PLUS SEVEN TIMES THREE = *Thirty-Two* x

$$\frac{45}{9} + 7 \times 3 = 32$$

Mac Oglesby
RFD 3
Putney VT 05346

Wordmath generates worksheets of simple arithmetic problems written in words. I wrote it as a term project for a graduate course on reading. The program, designed for use with my 5th and 6th grade math classes, meets these objectives:

1. Requires the students to read and write the word names for the numbers from zero to ninety-nine, and to read the words for the four basic operations — addition (plus), subtraction (minus), multiplication (times) and division (divided by). 2. Reinforces the correct *order of operations*. (My Dear Aunt Sally, or, do multiplication and division before addition and subtraction.)

As my school doesn't yet have a computer hookup, I produce worksheets at home. The school secretary makes classroom quantities. Normally, I trim off the answers before issuing the assignment. Since a misspelled answer is

WORDMATH 30 APR 77 17:53

HOW MANY PAGES? 2

890672

IN EACH PROBLEM, DO ALL MULTIPLICATION AND DIVISION BEFORE
ADDING OR SUBTRACTING. WRITE YOUR ANSWER IN WORDS.

1. SIX TIMES SEVEN MINUS FORTY-FIVE DIVIDED BY NINE
2. THIRTY-SIX DIVIDED BY SIX MINUS TWELVE DIVIDED BY TWO
3. TWO TIMES THREE PLUS EIGHTEEN DIVIDED BY SIX
4. FIFTEEN DIVIDED BY FIVE PLUS NINE TIMES THREE
5. EIGHT TIMES SIX PLUS SIX TIMES SEVEN
6. THIRTY-TWO DIVIDED BY EIGHT MINUS EIGHT DIVIDED BY FOUR
7. SEVEN TIMES EIGHT PLUS FOUR TIMES NINE
8. TWO TIMES THREE PLUS ONE TIMES FIVE
9. THREE TIMES SIX PLUS EIGHT DIVIDED BY EIGHT
10. SIX DIVIDED BY SIX PLUS EIGHT TIMES ONE

890672

1. THIRTY-SEVEN
2. ZERO
3. NINE
4. THIRTY
5. NINETY
6. TWO
7. NINETY-TWO
8. ELEVEN
9. NINETEEN
10. NINE

236983

IN EACH PROBLEM, DO ALL MULTIPLICATION AND DIVISION BEFORE
ADDING OR SUBTRACTING. WRITE YOUR ANSWER IN WORDS.

1. FOUR TIMES FOUR MINUS FOUR TIMES FOUR
2. FORTY-FIVE DIVIDED BY NINE PLUS FIFTY-FOUR DIVIDED BY SIX
3. THIRTY-TWO DIVIDED BY FOUR MINUS ONE TIMES THREE
4. SIX TIMES SIX MINUS TWO TIMES THREE
5. TWENTY-SEVEN DIVIDED BY NINE PLUS FIFTEEN DIVIDED BY FIVE
6. ONE TIMES ONE PLUS SEVEN TIMES SEVEN
7. FOUR TIMES TWO PLUS FORTY-FIVE DIVIDED BY FIVE
8. FOUR TIMES SIX PLUS EIGHT DIVIDED BY FOUR
9. FIVE TIMES SIX MINUS FIFTY-FOUR DIVIDED BY NINE
10. FOURTEEN DIVIDED BY SEVEN MINUS TWELVE DIVIDED BY SIX

236983

1. ZERO
2. FOURTEEN
3. FIVE

4. THIRTY
5. SIX
6. FIFTY
7. SEVENTEEN
8. TWENTY-SIX
9. TWENTY-FOUR
10. ZERO

0.573 SEC. 37 I/O
READY

RUN

WORDMATH 30 APR 77 17:56

HOW MANY PAGES? -1

- | | |
|-----------------|------------------|
| 0 ZERO | 50 FIFTY |
| 1 ONE | 51 FIFTY-ONE |
| 2 TWO | 52 FIFTY-TWO |
| 3 THREE | 53 FIFTY-THREE |
| 4 FOUR | 54 FIFTY-FOUR |
| 5 FIVE | 55 FIFTY-FIVE |
| 6 SIX | 56 FIFTY-SIX |
| 7 SEVEN | 57 FIFTY-SEVEN |
| 8 EIGHT | 58 FIFTY-EIGHT |
| 9 NINE | 59 FIFTY-NINE |
| 10 TEN | 60 SIXTY |
| 11 ELEVEN | 61 SIXTY-ONE |
| 12 TWELVE | 62 SIXTY-TWO |
| 13 THIRTEEN | 63 SIXTY-THREE |
| 14 FOURTEEN | 64 SIXTY-FOUR |
| 15 FIFTEEN | 65 SIXTY-FIVE |
| 16 SIXTEEN | 66 SIXTY-SIX |
| 17 SEVENTEEN | 67 SIXTY-SEVEN |
| 18 EIGHTEEN | 68 SIXTY-EIGHT |
| 19 NINETEEN | 69 SIXTY-NINE |
| 20 TWENTY | 70 SEVENTY |
| 21 TWENTY-ONE | 71 SEVENTY-ONE |
| 22 TWENTY-TWO | 72 SEVENTY-TWO |
| 23 TWENTY-THREE | 73 SEVENTY-THREE |
| 24 TWENTY-FOUR | 74 SEVENTY-FOUR |
| 25 TWENTY-FIVE | 75 SEVENTY-FIVE |
| 26 TWENTY-SIX | 76 SEVENTY-SIX |
| 27 TWENTY-SEVEN | 77 SEVENTY-SEVEN |
| 28 TWENTY-EIGHT | 78 SEVENTY-EIGHT |
| 29 TWENTY-NINE | 79 SEVENTY-NINE |
| 30 THIRTY | 80 EIGHTY |
| 31 THIRTY-ONE | 81 EIGHTY-ONE |
| 32 THIRTY-TWO | 82 EIGHTY-TWO |
| 33 THIRTY-THREE | 83 EIGHTY-THREE |
| 34 THIRTY-FOUR | 84 EIGHTY-FOUR |
| 35 THIRTY-FIVE | 85 EIGHTY-FIVE |
| 36 THIRTY-SIX | 86 EIGHTY-SIX |
| 37 THIRTY-SEVEN | 87 EIGHTY-SEVEN |
| 38 THIRTY-EIGHT | 88 EIGHTY-EIGHT |
| 39 THIRTY-NINE | 89 EIGHTY-NINE |
| 40 FORTY | 90 NINETY |
| 41 FORTY-ONE | 91 NINETY-ONE |
| 42 FORTY-TWO | 92 NINETY-TWO |
| 43 FORTY-THREE | 93 NINETY-THREE |
| 44 FORTY-FOUR | 94 NINETY-FOUR |
| 45 FORTY-FIVE | 95 NINETY-FIVE |
| 46 FORTY-SIX | 96 NINETY-SIX |
| 47 FORTY-SEVEN | 97 NINETY-SEVEN |
| 48 FORTY-EIGHT | 98 NINETY-EIGHT |
| 49 FORTY-NINE | 99 NINETY-NINE |

Fig. 1. Sample run.

marked wrong, number-word
lists are available for ref-
erence.

While I'd certainly prefer
interactive computing, the
students' response to these
worksheets has been very
positive.

Program A is a complete
listing of wordmath in BASIC
and a sample run is shown in
Fig. 1. ■

Program A. (Continued on following page.)

```
100 ' NAME: ELEMLIB***:WORDMATH
110 '
120 ' BY: MAC OGLESBY ON 08/20/76.
130 '
140 ' DESCRIPTION: THIS PROGRAM GENERATES PAGES OF SIMPLE INTEGER
150 ' ARITHMETIC PROBLEMS WRITTEN IN WORDS. EACH PAGE HAS INSTRUCTIONS,
160 ' TEN PROBLEMS AND THEIR ANSWERS. IF YOU REQUEST LESS THAN ONE
170 ' PAGE, THE PROGRAM PRINTS A CHART SHOWING THE NUMBERS ZERO THROUGH
180 ' NINETY-NINE AS WORDS.
190 '
200 '
1000 DIM W$(29)
1010 RANDOMIZE
```

'SAVE SPACE FOR 29 WORDS


```

1020 LET L$=CHR$(10)&CHR$(10)
1030 FOR J=0 TO 29
1040   READ W$(J)                                'W$( ) STORES NUMBERS AS WORDS
1050 NEXT J
1060   DATA ZERO,ONE,TWO,THREE,FOUR,FIVE,SIX,SEVEN,EIGHT,NINE,TEN
1070   DATA ELEVEN,TWELVE,THIRTEEN,FOURTEEN,FIFTEEN,SIXTEEN
1080   DATA SEVENTEEN,EIGHTEEN,NINETEEN,TWENTY,NULL
1090   DATA TWENTY,THIRTY,FORTY,FIFTY,SIXTY,SEVENTY,EIGHTY,NINETY
1100 PRINT "HOW MANY PAGES";
1110 INPUT T
1120
1130 IF T=>1 THEN 1310
1140
1150   'PRINT THE NUMBERS 0-99 AS WORDS
1160   PRINT "----"
1170   PRINT L$:L$:L$                                'PRINT 6 LINE FEEDS
1180   FOR J=0 TO 49
1190     FOR K=0 TO 1
1200       LET N(K)=J+K*50
1210       GOSUB 1810                                'GET NUMBER AS A WORD
1220     NEXT K
1230     IF J>9 THEN 1250
1240     PRINT " ";
1250     PRINT N(0);TAB(5);D$(0);TAB(30);N(1);TAB(35);D$(1)
1260   NEXT J
1270   PRINT L$:L$:L$:CHR$(10)
1280   PRINT "----"
1290   STOP
1300
1310 FOR I=1 TO T                                'PRINT T PAGES
1320   LET P0=1+INT(RND*10↑6)                      'P0 IS IDENTIFICATION NUMBER
1330   PRINT "----"
1340   PRINT P0
1350   PRINT
1360   PRINT "IN EACH PROBLEM, DO ALL MULTIPLICATION AND DIVISION BEFORE"
1370   PRINT "ADDING OR SUBTRACTING. WRITE YOUR ANSWER IN WORDS."
1380   PRINT L$
1390   FOR J=1 TO 10                                '10 PROBLEMS PER PAGE
1400     PRINT STR$(J);". ";                        'NUMBER THE PROBLEMS
1410     FOR K=1 TO 2                                'GENERATE 2 PAIRS OF FACTORS
1420       LET N1=1+INT(RND*9)                      'FACTOR RANGE IS 1-9
1430       LET N2=1+INT(RND*9)
1440       LET N(K)=N1*N2                            'N(K) STORES THE PRODUCT
1450       IF RND<.5 THEN 1500                      'SOME MULT., SOME DIV. PROBS.
1460       GOSUB 1810                                'GET PRODUCT AS A WORD
1470       LET D$(K)=D$(K)&" DIVIDED BY "&W$(N1)    'STORE DIV. PROB.
1480       LET N(K)=N2                                'N(K) STORES MISSING FACTOR
1490       GOTO 1510
1500       LET D$(K)=W$(N1)&" TIMES "&W$(N2)        'STORE MULT. PROB. WORDS
1510     NEXT K
1520     IF RND<.5 THEN 1560                          'SOME ADD., SOME SUBTR. PROBS.
1530     LET D$=D$(1)&" PLUS "&D$(2)                'ADDITION PROBLEM
1540     LET S(J)=N(1)+N(2)                          'S(J) STORES SUM
1550     GOTO 1580
1560     LET D$=D$(1)&" MINUS "&D$(2)                'SUBTRACTION PROBLEM
1570     LET S(J)=N(1)-N(2)                          'S(J) STORES MISSING ADDEND
1580     IF (99-S(J))*S(J)>=0 THEN 1600              'S(J) MUST BE POS. AND <100
1590     GOTO 1410                                    'GO TRY AGAIN ...
1600     PRINT D$
1610     PRINT L$
1620   NEXT J
1630   PRINT
1640
1650   'PRINT THE ANSWERS
1660   PRINT "----"
1670   PRINT P0
1680   PRINT L$
1690   FOR J=1 TO 10
1700     PRINT STR$(J);". ";
1710     LET N(K)=S(J)
1720     GOSUB 1810                                'GET ANSWER AS A WORD
1730     PRINT D$(K)
1740   NEXT J
1750   PRINT CHR$(10)
1760 NEXT I
1770 PRINT "----"
1780 STOP
1790
1800 'SUBROUTINE FINDS WORD FOR NUMBER
1810 IF N(K)>20 THEN 1840                            'SEE IF NUMBER IS 20 OR LESS
1820   LET D$(K)=W$(N(K))                          'STORE NUMBER WORD
1830   GOTO 1890
1840 LET X1=INT(N(K)/10)                            'FIND HOW MANY TENS
1850 LET X2=N(K)-X1*10                             'FIND HOW MANY ONES
1860 LET D$(K)=W$(20+X1)                          'STORE NUMBER WORD
1870 IF X2=0 THEN 1890                              'IS NUMBER A MULTIPLE OF 10?
1880   LET D$(K)=D$(K)&" - "&W$(X2)                'APPEND HYPHEN, ONES
1890 RETURN
1900
1910 END

```




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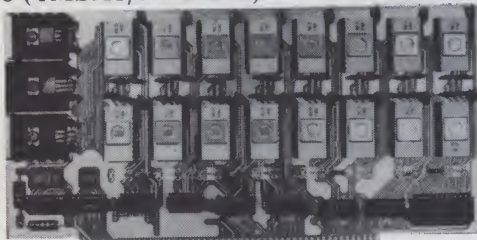
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The printer.



The Infoton terminal.

Ken Knecht
539 W. Addison St.
Chicago IL 60613

Ken has some interesting tales to tell in the following article about the use of a time-share service (while his system was down) and about his efforts to solicit business for his computerized billing service. Unfortunately, it's a story without a happy ending . . . but if you read the ending carefully you'll see where he inadvertently spills the beans and lets out the secret of his non-success. See if you can find it. — John.

Time for Timesharing ?

... some hints and pitfalls

There I sat, with umpteen dollars worth of computer equipment. Then came the age-old human desire: Why not make a buck with all this expensive stuff? That's when I opened Pandora's box.

I thought about good salable ideas for my system. Incidentally, this is an Altair 8800 with 44K memory, the usual other boards, a single Mits floppy, and a CRT terminal.

Actually, all this expensive stuff was only a potential at the time. I had bought and paid for it, but an essential part of my scheme — my disk memory — was in Mits' shop getting fixed. However, I was sure I'd get it back someday.

I had used the Altair disk enough to know what it



Diablo 1620 printer with access cover removed.

could do, together with disk Altair BASIC, so I could work its abilities into my schemes. I decided that while waiting for its return I would develop some money-making programs and get some clients lined up. That way, when the disk came back — instant riches! Well, it didn't work out quite that way, and therein lies the tale.

First, I thought about billing. Dentists and doctors seemed the most likely prospects. Regular clients and not too many services would be the thing to look for. My dentist showed me some ads he had received from billing services, so I had some idea of what to offer, and what to charge in order to compete with others. I decided to write a billing program and start with that service.

Next step — formulate a super letter, send it out to some doctors and dentists and hope the pounding on the door wouldn't disturb my neighbors. It didn't. A hundred letters got no answers.

In the meantime, I had purchased a couple of books on COBOL and was studying them. Boy, what a lot of stuff to remember! Next question: If I succeeded in writing a COBOL program and some of my letters were successful, how could I offer any services until my disk came back?

Temporary Time-sharing (DEC vs. Mits)

I decided time-sharing could solve both problems; it would give me a computer to use while I was waiting for mine, and since it had COBOL and FORTRAN compilers I could try out my expertise in those languages.

Since I now had a billing program written in disk Altair BASIC I thought it would be easiest to turn that into a program I could run on time-sharing. So I signed up for time-sharing on a DECsystem 20 and bought a modem. At any rate, after signing up I had to get an expensive bunch of manuals — how to use the system, BASIC and COBOL manuals, DEC-20 user's guide, edit manual, and RUNOFF manual for a great text editing program available on the system.

First I had to convert my Mits BASIC program to DEC BASIC since I was far from ready to try it in COBOL. I was really surprised at how powerful Mits BASIC is after comparing it with DEC BASIC. For example: In DEC BASIC (the version I had available on the DEC-20) one statement per line, IFs can only GOTO a line number, no abbreviation for PRINT (Mits is ?), no second dimensions in arrays, you can't GOSUB in an IF statement, no ELSE clause in an IF statement, no

editing in BASIC except for backspacing or line deletion (however, returning to the monitor permits extensive editing of any file, including a BASIC program file), no octal or hex conversion, no double precision, no LINE INPUT statement, no prompt in an INPUT statement, no machine language subroutines (I wouldn't have the faintest idea of how to write one for the DECsystem anyway). Your BASIC might not have some of these statements

I translated my program into DEC BASIC and tried to run it. The DEC-20 uses a BASIC compiler, which checks the whole program for missing RETURNS or RETURNS without GOSUBs, syntax errors, no FOR or no NEXT in a loop, etc. This saves many later program crashes. I got about a page of error statements, mostly in syntax. After I cleaned those up I had to start debugging my logic. Remember, I had never tried to run the Mits



Close-up of the Diablo 1620 printing mechanism.

either; I'm using Mits disk extended BASIC. In my experience, if you think a statement might work it probably will in Mits BASIC and probably won't in DEC BASIC.

However, DEC BASIC has some things going for it too. You can chain programs, it has all the extensive MATRIX features, the CHANGE statement, the NUM statement, and you can set margins and the number of lines on a page in software. And, boy-oh-boy, is that computer fast!

The disk file system is very different, you can only put one variable in each random access record in DEC versus any number (up to 128 bytes total) in a Mits record. Other than that, they are about the same in capability, but until you get used to them, very different in operation.

version of the program (around 500 to 600 statements), so this took a while. First most of my problems were with files, then with logic errors and formatted output. I also had a few problems getting my printer to type lower case and form-feed properly. After a lot of manual reading I finally corrected them.

Then I skillfully proceeded to erase the entire billing program. I had typed it all in (about three hours — I'm pretty slow) and was getting the errors out of it. I had finished working one evening and decided to delete a few files I no longer needed before signing off. I typed UNSAVE and then mysteriously got a character I hadn't typed in. So I hit the carriage return intending to retype UNSAVE and the files I

wanted to delete. Unfortunately, the computer didn't realize what I had in mind and typed out — UNSAVED, BILNG1-BAS and there went about five hours work. At \$7.50 an hour!

Now I make a safety copy of my programs in another file. I also now use Control U to exit a direct command line if I make an error. This causes the computer to disregard anything previously printed on that line.

Incidentally, I later discovered where the mysterious characters come from. If, for example, you are on the computer and your cat starts scratching something it shouldn't be scratching, you holler at it, right? Well, the modem picks up your voice and tries to make data out of it, usually printing a question mark.

Since I became interested in computers I have been hearing and reading about monitors and have seen listings for several versions. They seem like handy (and probably useful) things to have. After getting on the DEC-20 I now know what a really big monitor can do! I have a 342 page manual consisting mostly of monitor commands and how to use them. To cite a few: entering and receiving messages on the system, a synopsis of the extensive editing facilities (another manual for details), file specifications, using the line printer, remote controlling tape drives, terminal commands (to enable the system to operate all the features on your terminal), copying files, printing data and program files, and about a zillion more!

It is fantastic, and I use about one percent of its capability. Obviously, the DEC-20 is designed for the COBOL or FORTRAN user, as they have many more possible options than does the BASIC user. I think I'm the only one on the system using BASIC. Granted, time-sharing is expensive, but it gives me an opportunity to see how a

big operating system works, use COBOL, and gives me a back-up for my computer system as long as I keep the files up to date. To me it's worth it.

With all that memory available I can finally use all the arrays I want! Want a X(100,100) matrix? Just ask for it. No "out of memory" response. Also, with this system you can write on more than one sequential file at a time. Mits limits you to writing on only one sequential file. Of course Mits' system permits having quite a few random files open for read/write at any one time. However, the random access files are limited to a little over 2000 per disk, so you can't always use random files, especially when you only have one disk drive.

A Sorting Technique

In the process of writing my billing program I wished to sort the patient list from record number random access files to alphabetical (by last name) random access files. Since Mits disk will only hold a little over 2000 random access records, I couldn't sort a list of about 1000 records and still have room on the disk for the program, data files, etc. Obviously I didn't have enough memory to put 1000 record numbers and last names in an array and sort them that way. I finally decided to use sequential files for the sort. You can't erase and change data selectively in a sequential file, so I used the method shown in Program A. For those who are not familiar with Mits disk BASIC let me describe the following statements:

PRINT #1, D1\$ means write D1\$ on sequential file 1.

INPUT #1, D1\$ means read next item on sequential file 1 and call it D1\$.

OPEN "R", 1, "RECORD" means open file 1, "RECORD" for random access read and write.

OPEN "O", 2, "SORT1" means

open file 2, "SORT1" for sequential writing.

OPEN "I", 2, "SORT1" means open file 2, "SORT1" for sequential reading.

CLOSE 2 means close file 2 for read/write. It is also used with a following OPEN to start reading a file from the beginning again, like a RESTORE to a READ.

EOF(2) means end of file 2.

Field 1,20 AS A\$ means allow room for 20 bytes in file read buffer for variable A\$. GET1, 4 means get record 4 from random access file 1 and put the variables in the buffer as stated in the FIELD statement.

Now to the program. I'm sure there is a better way to do this, but it is the only method I've found that doesn't use a large memory-hogging array. If one has enough memory, then the record number and name could be put in an array and a ripple or bubble sort used. Though the time-sharing computer has plenty of memory, I want to be able to run this program on my computer too.

This simple little subroutine turned out to be a lot more difficult than I had imagined. It took a long evening's work with many runs to get it right. Of course, it is all very obvious now. Isn't that always the way?

Line 3999 is just to initialize the routine. In use, R and E9 (used in the printing part of the subroutine, not shown here) would be set earlier in the program. File 1 contains the master list of clients in record number order. Lines 4000-4050 get each record in turn and puts the record number (X%) and last and first names in the sequential file SORT1.

In lines 4060-4170 we pull out the first two names in SORT1, choose the lower (in alphabetical order) and call it F1\$. Then we compare the rest of the names in the file to F1\$ and change F1\$ if any of them are lower. We finally end up with the lowest name and rename it G1\$ in 4160.

Then we write it into SORT2. All this time the record number associated with the name has been tagging along as Z. Then we close and open the files to reset SORT1 to the beginning and set our counter R1 to delete one count. When it reaches 0 we have been through SORT1 R times and have the whole file in order on SORT2.

Next is where I had my problems. This routine runs from 4200-4310. Originally 4210 and 4220 were reversed in order and lacked the IF G1\$ clause. First I had to add line 4230. Otherwise if the first two names in SORT2 were less than or equal to the



The modem.

highest names in SORT3 then F1\$ would remain the last used F1\$ and the routine would keep printing the last name in SORT3. Then I kept losing the first name on the list. Reversing the statements in 4210 and 4220 cured that. The routine works and now takes about 20 seconds to sort ten names. This will be very long in lists of 500 to 1000 names so I am trying to find a better way.

The Hardware

You may have noticed I mentioned my printer earlier. Where did that come from? Well, since I only had a CRT terminal I obviously needed a printer for my business. If you're going to print bills you have to have something to print them on. I concluded the printer should have a keyboard so I could back up my CRT terminal. (I am a firm believer in redundancy.) It should print lower case (for using it with a word processing program for writing magazine articles), non-matrix characters for legibility (so my copy would look like it was typed on a typewriter) and ASCII input.

After some research on what was available and for how much I discovered another feature I wanted — a forms tractor. This attachment uses rolls of paper with holes along the edges. The tractor guides the paper, pulls it up to the next line, and keeps it lined up correctly in the printer. This allows precise positioning of the printhead on the paper. Not necessary by any means, but convenient.

You can get this kind of paper in various colors, widths, and weights with perforations to remove the holes along the edges if you wish. The paper can also be perforated for standard paper size (8½ x 11 for example). I also decided I needed the form-fed feature, which, when the printer gets a Control L in software, automatically advances to the top of the next sheet of paper.

```

3999 E9=1:R=10:OPEN"R",1,"RECORDS"
4000 OPEN"O",2,"SORT1"
4010 FIELD#1,20 AS A$,15 AS B$
4020 FOR X%=1 TO R
4030 GET#1,X%
4040 PRINT#2,X%,CHR$(34):A$+B$:CHR$(34)
4050 NEXT
4070 CLOSE 2:OPEN"I",2,"SORT1":OPEN"O",3,"SORT2":R1=R
4080 INPUT#2,X,D1$,Y,E1$
4090 IF D1$<E1$ THEN F1$=D1$:Z=X:GOTO 4110
4100 IF D1$>E1$ THEN F1$=E1$:Z=Y
4120 IF EOF(2) THEN 4160
4130 INPUT#2,X,D1$
4140 IF D1$<F1$ THEN F1$=D1$:Z=X
4150 GOTO 4120
4160 G1$=F1$:Z1=Z
4170 PRINT#3,Z1,G1$
4180 CLOSE 2:OPEN"I",2,"SORT1":R1=R1-1
4190 IF R1=0 THEN 4280
4200 INPUT#2,X,D1$,Y,E1$
4210 IF E1$<D1$ AND E1$>G1$ THEN F1$=E1$:Z=Y:GOTO 4240
4220 IF D1$>G1$ THEN F1$=D1$:Z=X:GOTO 4240
4230 F1$="ZZZ"
4240 IF EOF(2) THEN 4160
4250 INPUT#2,X,D1$
4260 IF D1$<F1$ AND D1$>G1$ THEN F1$=D1$:Z=X
4270 GOTO 4240
4280 CLOSE 2,3
4290 OPEN"I",3,"SORT2":OPEN"O",4,"SORT3"
4300 IF EOF(3) THEN CLOSE 3,4:GOTO 4320
4310 INPUT #3,X,D1$:PRINT #4,X:GOTO 4300

```

Program A.

These are very convenient for typing bills and manuscripts. I finally decided on the Diablo 1620 printer, which had everything I wanted plus changeable type fonts.

Going After the Business

I mentioned sending out form letters to doctors and dentists soliciting billing business. My first attempt used printed form letters which even included an SASE. The added time to type envelopes with my name and address and the 13 cent stamp seemed like a reasonable expense if it would draw a few more responses. However, no answers. I thought about it for a while and decided that someone else had plowed that ground before me. Then I got out the Yellow Pages and went walking for some other likely business needing my services. I finally settled on telephone answering services.

My billing program is designed to input new charges and payments from old customers, with individual service code numbers and charges if the charges on the bill are to be itemized. I can also input new customers with itemized charges. In the

billing printout the program types out a master list of all clients in alphabetical and account number (record number) order. It also prints out a transaction list of all names, charges and payments of clients billed; an aged list showing balances due by current, over 30 days, over 60 days and over 90 days; and a list of all services performed with number of times, services, and total charges for each (done only if services are itemized). Then the computer types out my bill to the client.

Obviously a good client has repeat customers and few services, ideally no itemized services on the bill. The less information I have to type into the computer the easier and faster I can complete the job. Of course I print all the new charges and customers into disk files, then let the computer type all the bills at once.

The telephone answering services filled the bill nicely, and this time I sent out individualized letters. Same content for each one but they each had the service's name and address printed at the top like a business letter. I sent out about 35 letters, each

with SASE included. No response again.

More thought. Maybe I should try to get work printing reports. With the word processing program I could justify right and left margins, and each report, even if multiple copies were desired, would be an original. I could learn a little about accounting. Perhaps I could write some sort of program for accountants.

So far I have a book on elementary accounting with a few chapters read, but no ideas. I think mainly I need another book — this one I don't understand at all. Remember, if I have to type in a lot of data, my service will not be very efficient. Now I know why key-punching computer cards is such a big business. Unfortunately, key-punched cards are a little beyond my capabilities. Another possibility — write business programs for sale, individualized for the business, to be run on time-sharing. That would mean one nice payment and no worries about it afterwards. Perhaps I could make some contacts with other computer service companies and subcontract writing programs. Better get

back to the COBOL books.

A lot of ideas, but I haven't yet been able to figure out how to implement them. While thinking, I decided to go back to the Yellow Pages and look again. This time I sent out letters to about 15 different businesses, individualizing each letter. To do this I just wrote a bunch of paragraphs and used the appropriate ones in each letter to the various businesses. I sent out 65 letters,

this time with a return envelope but no postage. No answers again. To quote some magazine publisher (I can't think of which one offhand), "Never Say Die." I just finished 65 letters to commercial photographers. Maybe there's a winner in that group.

Late flash! Got an answer from an earlier letter to a maid service outfit. Strange fellow. First I had to convince him I wasn't going to

sell his client list, then when he discovered I was a new business and had no customers (I had to go and tell the truth, messy sometimes but easy to remember what you told someone), no sale. You know, "Don't call me, etc.". So back to the photographers.

For some reason, I have this feeling that once I get a customer or two all hell will break loose and I will have all the business I want. I sure

hope so. At any rate, I'm not ready to give up yet. Maybe if I got some fancy letterheads printed up...

Well, I hope I gave you a few ideas so when you try to break into business with your computer you will know what not to do. Of course, I have a couple of really super ideas that came to me while I was writing this that I'm not going to tell you about. At any rate, jump in, the water's fine. Good luck. ■

Some Hints from "Never Say Die"

From the standpoint of learning to program, Ken is doing a fine job. But, from a salesman's point of view, he's dropping the ball. Perhaps I can pass along some ideas for others thinking of going into the same woods in which Ken got lost.

Before writing a long program to handle a particular business I would do a little research. In the case of a program for dentists, I would first check with my own dentist and find out how much need a dentist has for such an obviously valuable service. I'd level with him that I have a new computer and am looking for ways to help pay for the thing — what does he think my prospects are in computerized billing for dentists?

If the answer is a gentle assurance that I am not the first to think of computerizing dental bills — in fact the real money seems to be in renting lists of dentists names to computer services — I would then try to find out if there was some way for me to get into this competitive field. I have an advantage: cheapo equipment and even cheaper time (my own), so I should be able to be competitive with any commercial service bureau.

You might even start getting some literature from the local computer service bureaus and see what you are up against in services and

charges. You'll find them (don't be surprised at how long the list is) in the Yellow Pages under "Data Processing Services."

If your dentist is a good friend you might be able to get him to show you what his own service bureau is doing and how much it costs. Get out your calculator and see if you can be competitive.

Let's say you can beat the hell out of Procom Associates on price. Now you have to develop a more solid air... no customer wants to think he's dealing with a one man basement operation where his patient records might be lost at any time. Some good looking letterhead will help with this... and envelopes. Spend a little bit here... dress it up... maybe a name like National Data Processing.

You should individually write each solicitation letter and stress your strong point: He'll save a lot of money. You might even remind him that a dollar saved is at least ten dollars earned so it is important to him to keep down expenses as much as possible... it's a lot easier than working more hours.

If you can make an educated guess as to how much you might save him, put this in terms of hours he won't have to work. Again, your friendly dentist should be able to give you some guidance on how much a dentist thinks his time is worth. Can you save him a

week's work in a year? If you can, you are offering him an extra week off.

Very few, if any, prospects will grab the bait the first time out. It takes repetitive advertising to sell, so plan on sending at least six letters, each stressing some way that he will benefit from your service. For instance, if he wants any changes in the way his present service is run he is probably up the creek. Not so with you... if he wants a special service you will be able to give it to him at a fraction of the cost elsewhere. Maybe he'd like to keep track of specific cross references on patients... you can add the data to the file and write a program to sort on that for him. Look for ways you can give your customers added benefits.

After a half dozen letters spaced about three weeks apart, it is time for a phone call. Check with his receptionist and see when he usually talks with salesman and try to get him during off hours, if any. Once you get him on the phone you want to find out if he's seen your letters. If he has, then try to find out what his objections are to giving your service a try. You may not have any answers to the objections right now, but you'll have something to work with and be ready for the next chap you contact.

In order to get started you might offer to run at no

charge to him, in parallel with his present service for a couple of months so he can see that even though you charge less you can do an even better job. Explain that you have a lot less overhead than his present bureau — that you are using much more modern and efficient equipment, so your costs of doing business are lower. Give him a guarantee of holding your price for a year or more.

If a dentist is still sending out bills by photocopy method or by having his receptionist type them, he might just be able to let his dental assistant double as a receptionist and save an entire salary. Don't forget to mention that computerized bills get paid faster than the old style. People are afraid of getting messed up with computers... what was the TV movie awhile back where a computer systematically killed off a bunch of people who had crossed it?

The first sales are the hardest because you don't know what you are doing or what you are up against. Once you make a sale you'll know a lot more about selling.

If the dental service business isn't worth byting into, look around for others. Talk to friends who are in business... to businessmen in your local area... see what they need. Never Say Die!

... Wayne

You Asked For It!

You asked for the Intel 8080A CPU	We gave you the VECTOR 1
You asked for a real-time clock	We gave you the VECTOR 1
You asked for eight level vectored priority interrupts	We gave you the VECTOR 1
You asked for a jump-on-reset and resident monitor	We gave you the VECTOR 1
You asked for the S-100 bus	We gave you the VECTOR 1
You asked for an 18 slot fully shielded motherboard	We gave you the VECTOR 1
You asked for a rugged, reliable chassis	We gave you the VECTOR 1

*Then . . . You asked for the compactness and convenience of installing your mini-floppy disk directly in the front panel. NOW . . . We give you the **VECTOR 1+***



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RADIO SHACK'S SURPRISE

by Sherry Smythe

Radio Shack made a giant step forward in improving their product image when they introduced the TRS-80 Micro Computer System at their press party in New York City on August 3 ... they unveiled a tiny, sleek modular computer.

The Z80 chip, 4K memory and 4K ROM are housed with the keyboard and it costs under \$400. Completing the primary system is a terminal and cassette recorder making the total cost less than \$600 for the entire assembly. The 8K memory option is only \$99.95 more. Want 16K memory option? Add less than \$300.

Programs are available too! Want a payroll program for about \$20 that can handle up to 15 employees? How about a program to help the kids with their math? Games and Graphics are available too ... all priced very reasonably.

Wayne needed a computer for his COMPUTERMANIA commercial in Boston the next morning and Don French, marketing manager for Radio Shack, loaned us the TRS-80 complete with tape recorder, terminal, and a small program especially written for COMPUTERMANIA to use as a demo when Wayne was on camera. Don packed up the microprocessor and accessories in two pasteboard boxes and they traveled back with us in the plane to Keene, New Hampshire.

After routine airline baggage treatment and a 20 mile ride to Peterborough, we plugged in the unit, ran the tape through the recorder and IT WORKED! The first time, it worked! From past obser-



Radio Shack's complete TRS-80 Microcomputer System, consisting of a 53-key professional-type keyboard and microcomputer plus regulated power supply, computer-controlled data cassette recorder, and 12" video display monitor, is suitable for business, educational and home applications. Available exclusively from Radio Shack stores and dealers, nationwide, for \$599.95.

vations of computers and their oft lack of dependable performance, I have formed very biased opinions, very negative biased opinions ... example of which was when I copied down the entire COMPUTERMANIA program in my notebook even though I knew it was taped when we were in NYC. I knew we'd have trouble if I didn't have my notes. Not so — the TRS-80 accepted the program and worked perfectly at first try when we got to 73 Headquarters ... and again after the ride to Boston for the television commercial taping the next morning.

Wayne returned the TRS-80 and assorted gear to the Radio Shack booth at the Boston Personal Computing Show. These little gems stole the show from everybody there ... they've certainly started another microcomputer revolution.

At my booth I talked to several computerists who pooh-poohed the idea that Radio Shack really has as good a computer as I described to them. I asked them to go look for themselves and tell me what they really thought from their experienced viewpoint. Without exception, they liked what they saw and thought the TRS-80 was a terrific little computer and should set the industry on its ear. The only negative comment was from an ex-Radio Shack dealer who would have preferred it to program in APL instead of BASIC; but still he said it was better than anything he had imagined that Radio Shack would have.

By the 8th of August, I really got antsy and called Don French in Fort Worth, and asked him to arrange for me to use the TRS-80 to learn BASIC and write the

review from a "user's" standpoint. I felt that being an average nonelectronic person of nontechnical background and ability that if it worked for me, it should work for anyone. I wanted only to use it, not rebuild or repair it. Using the Radio Shack manual, Bob Albrecht's books, *BASIC* and *My Computer Likes Me When I Speak in BASIC*, I am getting a good handle on BASIC programming. So far in the three days before press time I am learning the fundamentals of programming and am getting more enthused by the minute. I've had nothing but excellent results. I recommend this computer especially to any neophyte wondering which to buy to learn computing. The TRS-80 has me hooked — it's so easy to use! In about three months when the Radio Shack DISC drive and printer are available maybe I'll have a business program written that we can use here at *Kilobaud*, and it can pay for itself.

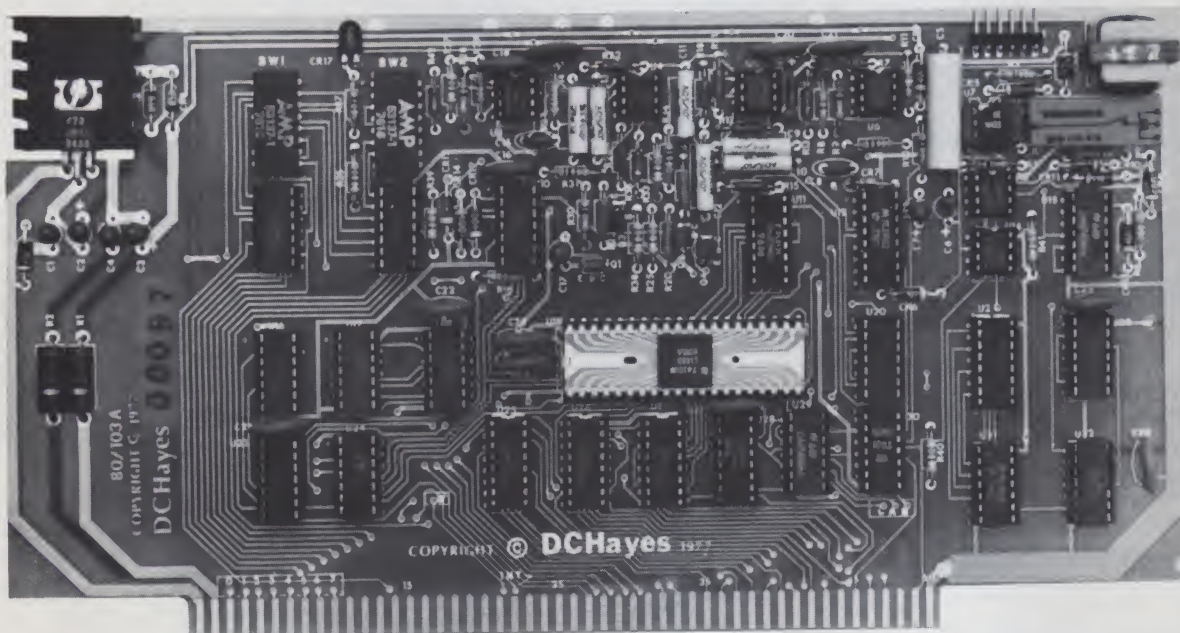
TRS-80s will be marketed in Radio Shack stores and Tandy Computer stores (which will also handle other brands of computers). For service, you'll have to take it to Radio Shack to send to one of their service centers throughout the country with NO FREIGHT CHARGES for the customer.

My son will probably find one of these under the Christmas tree this year. I'm already thinking about writing a program to have it help me with my gardening ... let's see, the avocado gets watered every other day, and tomatoes once a week, etc. ...

WAITING for the Mail?

THE 80-103A DATA COMMUNICATIONS ADAPTER WILL PUT YOU ON LINE TO A MULTITUDE OF TERMINALS AND COMPUTER SYSTEMS. YOU WILL GET THE INFORMATION YOU NEED WHEN YOU NEED IT, WHERE YOU NEED IT. WHETHER YOU NEED PROGRAMS OR DATA TRANSFERRED OVER THE DIAL TELEPHONE NETWORK, YOU GET FAST EFFICIENT SERVICE ANY TIME OF DAY OR NIGHT. WHILE OTHERS ARE WAITING FOR THE MAILMAN TO DELIVER, YOUR SYSTEM IS WAY AHEAD.

80-103A DATA COMMUNICATIONS ADAPTER



The 80-103A DATA COMMUNICATIONS ADAPTER was developed to function as an S-100 bus compatible serial interface incorporating a fully programmable modem and Telco interface. These functions are usually accomplished by the use of two separate modules: 1) a serial I/O board, and 2) an external modem. By combining these features on a single board, the 80-103A can offer microcomputer applications significant cost/performance advantages over other implementations.

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- ORIGINATE OR ANSWER MODE
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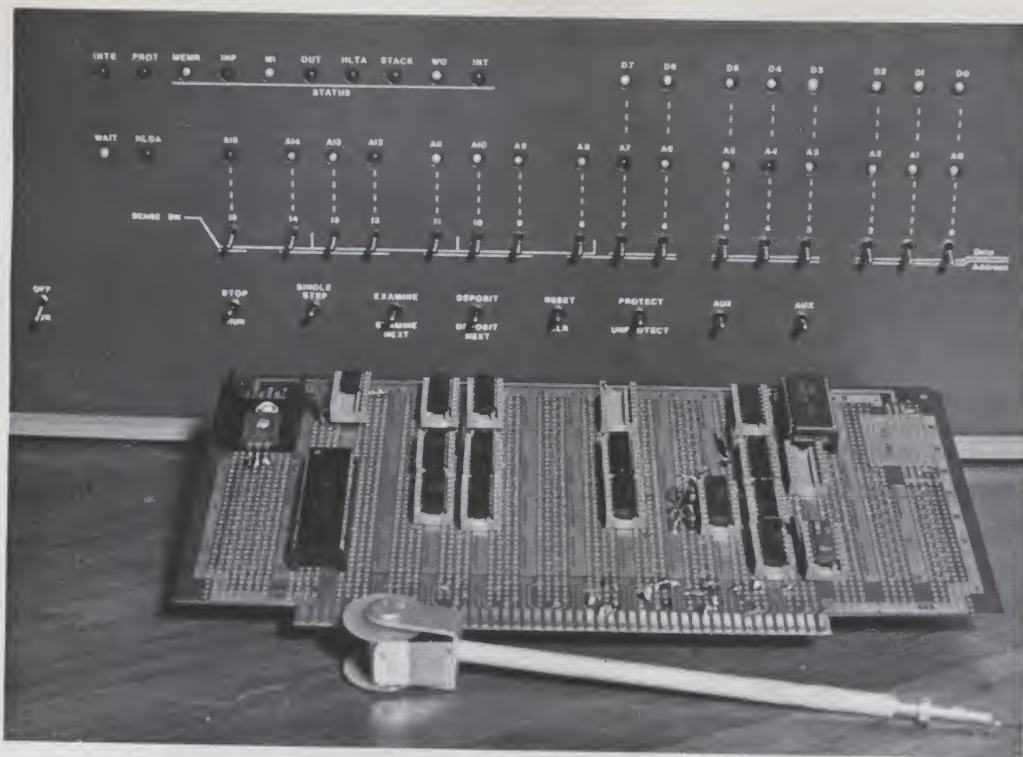
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Bare Board with manual is \$49.95

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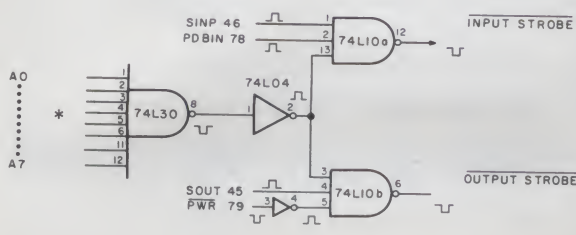


Prototype board with Vector Wire-Wrap tool shown. Resistors next to IC on right side of board are pull-ups used with 7445 in place of a 7442. Photos by Pat Twomey.

William T. Walters
2820 N. Newell Rd.
Oak Harbor WA 98277

Build a Universal I/O Board

... for your Altair



*Add inverters (74L04) to each address line as needed to result in logic 1 on all input lines to the 74L30 when the desired address is called.

Power	+5	Gnd
74L04	14	7
74L10	14	7
74L30	14	7

Fig. 1. Labels and pin numbers reflect Altair bus. (From May 1976 73 by Dick Whipple and John Arnold.)

Over the past two years I have watched the evolution of home computers but always balked because so many expensive add-on devices were required to make them do anything. In particular, I never saw any comprehensive material on Input/Output peripherals for the Altair 8800, in which I was most interested. Despite my inner feelings of how expensive this new hobby was going to be, I plunged head-long and finally got my Altair.

With the Altair home and working I now faced a decision. Do I spend several hundred dollars and get several I/O boards, one for parallel and one for serial? Should I purchase one do-all I/O board? Or try to build an I/O board? I decided to build one and I have been simply delighted with the results.

I am not an engineer and have no special knowledge of TTL (I can never remember the truth table for a NOR or a NAND gate!), but I can read articles and diagrams and have a reasonable amount of time to experiment with different circuits. The result is an I/O board for less than \$60 that provides one serial input/output port, two parallel input ports (one latching and one non-latching), and one latching parallel output port.

This board may be expanded easily and inexpensively with each parallel input or output port costing no more than \$4.50. Here then is a collection of notes, diagrams and hints so that you may achieve the satisfaction which goes with building something useful that works well and saves you money.

Construction

All circuits used in the prototype I/O board were assembled using wire-wrap construction and checked out with a working Altair 8800 and an inexpensive volt-ohm meter. Other test equipment was available such as an oscilloscope and digital multi-

I used the Vector Wrap-N-Strap tool, which has to be one of the best tools made for the hobbyist-experimenter. The connections it made are extremely good and the amount of time it saved was fantastic. If you are uncertain of wire-wrap methods, I invite you to look over Dennis Brown's excellent article in *Kilobaud* #1. The Vector Company makes prototype boards for the Altair Bus and that's what I used (stock number 8800-V) to build the I/O circuits in this article.

If you wish, you may use conventional solder techniques or a wiring pencil, but by all means — *use sockets*! Don't let the extra cost of wire-wrap sockets discourage you from using wire-wrap. The convenience will more than make up for the extra cost over conventional sockets.

The first requirement of an I/O board is to provide the sometimes elusive Device Select or I/O strobe as it is often named. There are various methods used to produce a unique I/O strobe for each of the 256 possible input and output devices. Chances are that you won't need all 256 devices but generally will need anywhere from one to sixteen I/O

strobes. As a practical minimum, it seems that the simplest method of generating an I/O strobe will use 3 integrated circuits (ICs). These are a 74L04, 74LS30 and a 74L10 (see Fig. 1). This is alright for a little while, but any expansion will require more of the same so it is not very versatile. A similar version is given (Fig. 2), slightly modified, from the April 1976 issue of *Byte* by R.J. Bosen. By far the most versatile and easily expandable circuit is from the same issue of *Byte* by J.M. Schulein (Fig. 3). If you can't find the 8131 comparator or just don't want to spend \$3 for one, then the example of Fig. 4 will show how to use a 74LS138 as a suitable replacement. As it turns out the 74LS138 makes for easy expansion and is therefore highly recommended. To expand this circuit from 4 I/O strobes to 8 I/O strobes, replace the 7442 with a 74154 and adjust a few address lines as shown in Fig. 5. Now you have 8 input and 8 output strobes and the package count of the circuit hasn't changed except for the possible addition of a 7404, depending on your desired beginning address segment. And, if you did use the 74LS138 instead of the 8131, you can continue to expand and add another 16 I/O strobes (8 in, 8 out) for the cost of another 2 ICs as



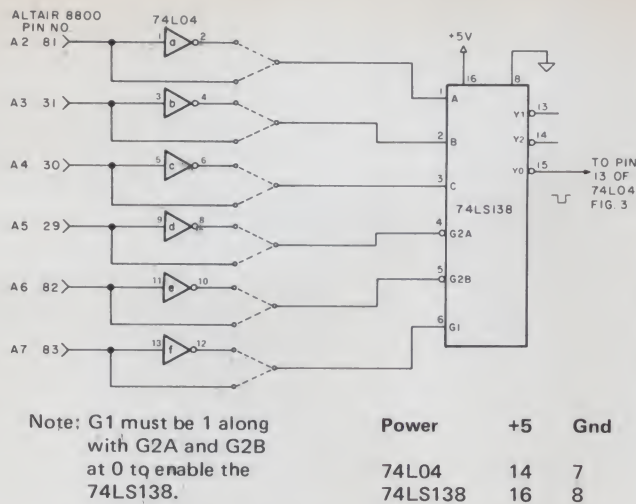


Fig. 4. Substitution of a 74LS138 for the 8131 of Fig. 3.

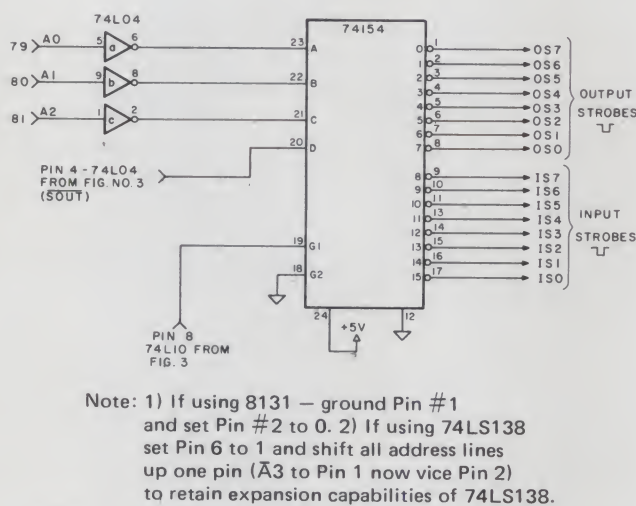


Fig. 5. Expansion of the basic circuit from Fig. 3.

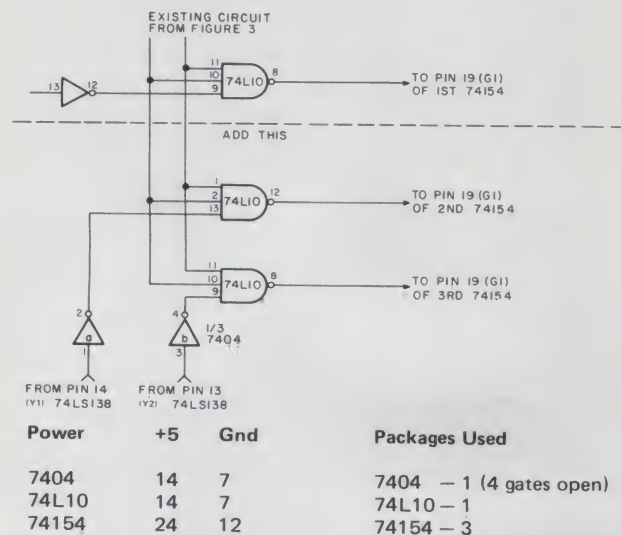
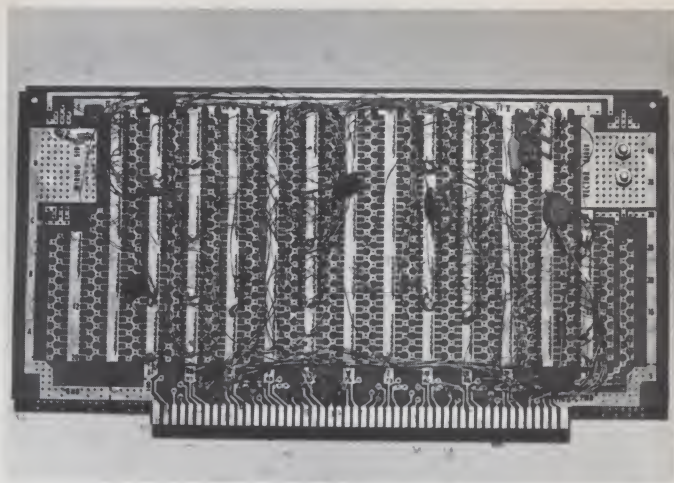


Fig. 6. To increase the number of I/O strobes even more, use this circuit to enable more than one 74154.



Wiring side of I/O board. See, it doesn't have to be neat to work!

shown in Fig. 6. Now let's see how to use these I/O strobes that have been generated.

Parallel Input

A latched keyboard (a keyboard in which the ASCII code is held on the output lines after a key has been depressed until an acknowledgement by the computer interface) is by far the easiest device to interface. In fact most I/O boards assume that your parallel input data is from a latched input device (which isn't always so). Fig. 7 shows a pair of 74125 non-inverting (a high in gives a high out) three-state buffers which are enabled (allow data to pass) when the control line (pins 1,4,10,13) are brought low and at all other times the outputs from the buffers are in the high impedance state. This simply means that for all practical purposes the buffers are not connected to or loading the bus at all. Any non-inverting, three-state buffer device is suitable for the circuits shown in this article, but I like the 74125 because it is inexpensive. The lower cost is due to each buffer having its own enable pin, which means you get to do more wiring and also there are only 4 buffers to a chip.

Another ideal use for the non-latching buffered input is for use as a status port. For this use a status input port must be able to accept a signal from an external device

(either input or output) and gate this onto the bus at the proper time. This way the program may determine if an output device is busy or available, or if an input device has data from the program to use. The status port is used in what is called a polled system. A polled system will loop until a requested device either becomes available or has data for the computer to input.

This is in contrast to an interrupt driven system in which an external device (input or output) will interrupt the computer which causes the current program execution to halt and then to execute a jump or branch to the service routine for the device which generated the interrupt.

In conjunction with the status port many hobbyists ask what popular conventions are being used, and express concern about having to modify software they receive from others to suit their own I/O structure. There really isn't any set of standards (is anybody listening out there?) but some of the more popular conventions are given in Fig. 8. The prototype conforms to the Mits SIO A,B,C, (not revised) which was requested for the Dazzler contest and also has been used in several other articles.

Latched Parallel Input

Latched parallel input may

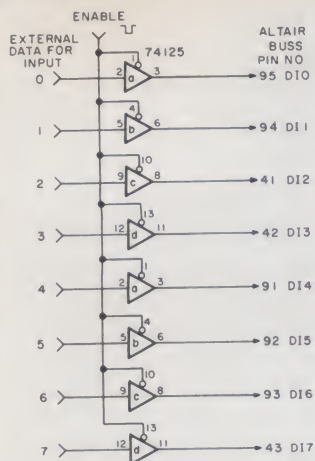


Fig. 7. General purpose input, output or buffer circuit shown here as an input port. Identical circuit is used to buffer the Altair output bus (by grounding the enable line) for all output ports on the prototype board.

be obtained by using any of the circuits of Fig. 9. Note that the use of any except the 8212 will require two added external functions. Only the 8212 has built-in three-state buffers and a signal which may be used as a status port input to signal Data Available. All other circuits will need, as a minimum, the external three-state buffers. For this reason an 8212 was used in the prototype board to reduce package count. When the strobe input is pulsed to 1 and then back to 0 the latches inside the 8212 grab the data present at the Data Input pins. Also, on the falling edge of the strobe input the INT line goes to 0 and stays there until the three-state buffers are enabled by the I/O strobe on pin 1. This way the INT pin may be used as a status flag (0 = Data Available, 1 = No Data Available) to the status port. Be sure that your strobe signal pulses to logic 1 and valid data is present during the transition from 1 back to 0. If your keyboard strobe signal goes to 0 and remains there while a key is depressed, use the 7402 circuit in Fig. 9 to provide a clean strobe pulse to the 8212 while data is valid from the keyboard. But check the keyboard documentation just in case the data remains valid after this type of keypressed signal.

If your keyboard is a

latching type which requires an Acknowledge signal to free the keyboard to input another character you may use the 8212. In this case get the Acknowledge from the Status (pin 23 of the 8212). If your keyboard uses a positive strobe for the Acknowledge use an inverter gate to change the polarity of the pulse.

Parallel Output

The circuits of Fig. 9 apply also to parallel output. Notice that all but the 8212 require a positive pulse to latch data from the output bus so be sure that you include an inverter between the I/O strobe that you use and the latch pins. Also, you will not need three-state buffers on the outputs, so there is no reason to use the more expensive 8212 in this application. In the prototype board 7475s were used for each parallel output port and the main output bus from the computer was buffered with a pair of 74125s to drive all the output ports so that bus loading would be reduced. The final system diagram should help you visualize this.

Serial Input/Output

Eventually, nearly everyone will need to convert parallel data into serial data and back again. The relative merits of software versus hardware conversion is an old

subject and will not be kicked around much here. True, software conversion costs less and may be a bit more versatile than hardware, but I favor the hardware approach illustrated here.

The UART, (Universal Asynchronous Receiver-Transmitter) was designed expressly to perform this task of serial-parallel and back again. Its use has been described in many different articles except that no one discussed exactly how to

interface it directly to the computer bus. The UART was designed to mate directly to a computer bus as all outputs from the UART are three-state buffers with separate enable lines provided for the status bits (called flags) and the 8 bits of parallel output. However, the Altair bus has 1k Ohm pull-up resistors on the eight lines of the Data In bus and the UART (TMS-6011) is specified as being able to drive one TTL load. As a

Device	Conventions			Bit Location	
	Channel Status	Data	Status Bit Active	Input Data Ready	Output Data Ready
Mits S10 A, B, C	0	1	Low	0	7
Mits ACR	6	7	Low	0	7
Mits S10 A, B, C (REV 0)	0	1	High	5	1
Mits 88 PIO	0	1	High	2	1

Fig. 8. Port assignments and Status bit locations for various Mits interface boards.

Power	+5	Gnd
74125	14	7
Packages Used		
74125 - 2		

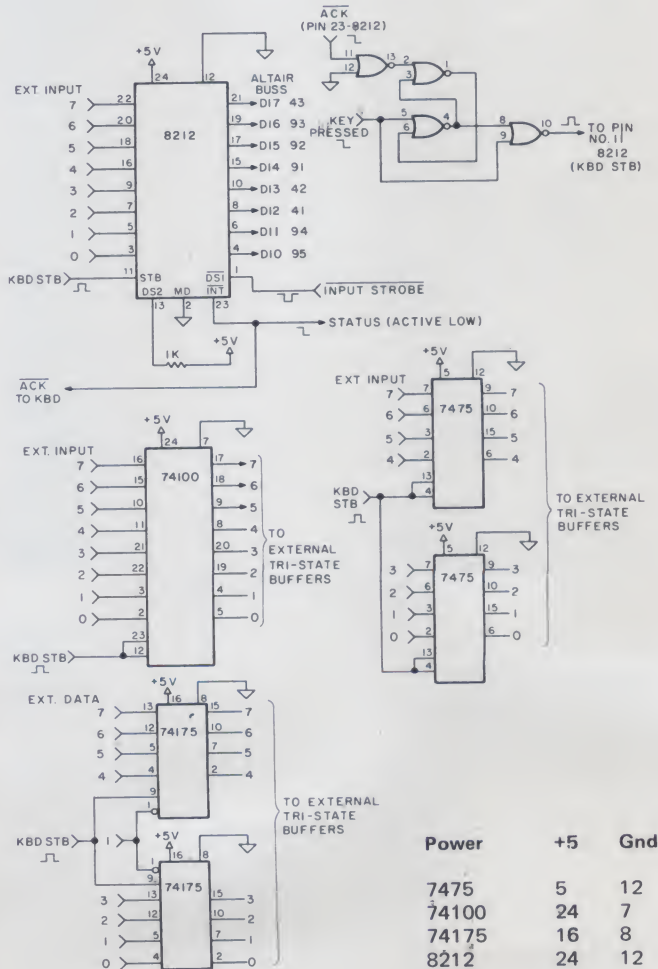
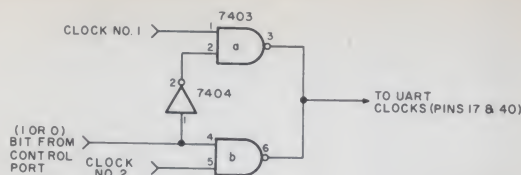
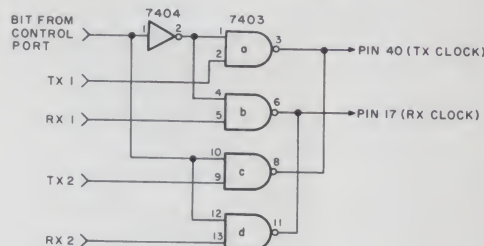


Fig. 9. Input/Output latching circuits. Note the various strobe requirements — for those circuits not having internal three-state buffers the buffers are added (from Fig. 7) and enabled by the I/O strobe.

Power	+5	Gnd
7475	5	12
74100	24	7
74175	16	8
8212	24	12



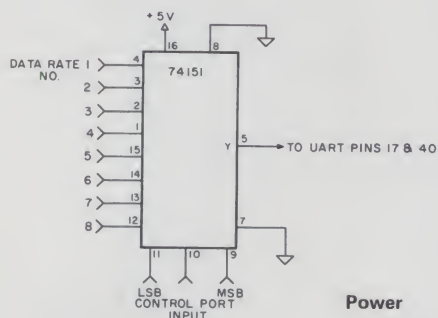
or if you need a separate clock for the receive and transmitter sections —



Note: UART input pins contain their own pull-up resistors so no external pull-ups are required even though using open-collector logic.

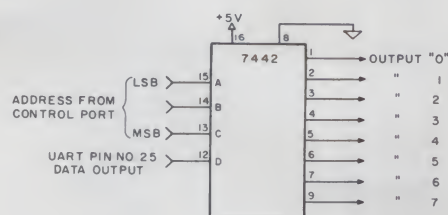
Fig. 11a. 7403 used to select 1 of 2 different clocks for the UART. This could also be used in place of Fig. 11b if you have only 2 different devices for UART input (see text for explanation).

Power	+5	Gnd
7403	14	7
7404	14	7



Power	+5	Gnd
74151	16	8

Fig. 11b. Circuit to select more than two baud rates for UART clock input. This may also be used to select multiple inputs to the UART and in that case pin 5 would be connected to UART pin 20 instead of the clock (pins 17 & 40).



Power	+5	Gnd
7442	16	8

Fig. 11c. Use this for delivering the output of the UART to more than one device.

result, if you interface the UART's parallel data output directly on the Altair Data In bus you will experience random data input as the UART is not able to completely pull down (sink) the Data In bus. There are two ways to remedy this condition. One is to change the value of the pull-up resistors used on the CPU board of the Altair. This is not recommended as I do not know what effect it will have on proper CPU operation. The second and the method used on the prototype board was to use the trusty 74125 three-state buffers and enable their outputs with the I/O strobe. Fig. 10 shows the different connections used on the prototype board. Pin 22 is the status and is high when the UART can accept another character for conversion and low when it cannot. Pin 23 is the load and this is connected to the desired output strobe from the 7442 or 74154 of Fig. 3 or 5. With this you need only to load the data to be output to the accumulator and execute an out instruction, addressing the UART port to have your serial conversion take place. For serial to parallel conversion pin 19 will provide status by

going high when data has been received and will remain low when no data has been received. The only catch to using this signal is that pin 18 must be pulsed low to reset pin 19 so that it may signal receipt of another character. Failure to reset pin 18 will result in pin 19 remaining high after the first character is received and every time status is checked the program will think that data is available from the UART. You can see that a potential disaster would be in the making there! This is solved very easily by connecting pin 18 to the enable lines for the buffers that are used on the UART outputs. This way when the buffers are enabled to allow the data from the UART to gate onto the input bus the Data Available flag will be reset.

Summary

Each of these modules may be combined in building block steps which will result in the I/O board that you want for your particular system. Build the I/O strobe section first and verify that it functions correctly by using the single step mode of your Altair. Then go on to the different input or output

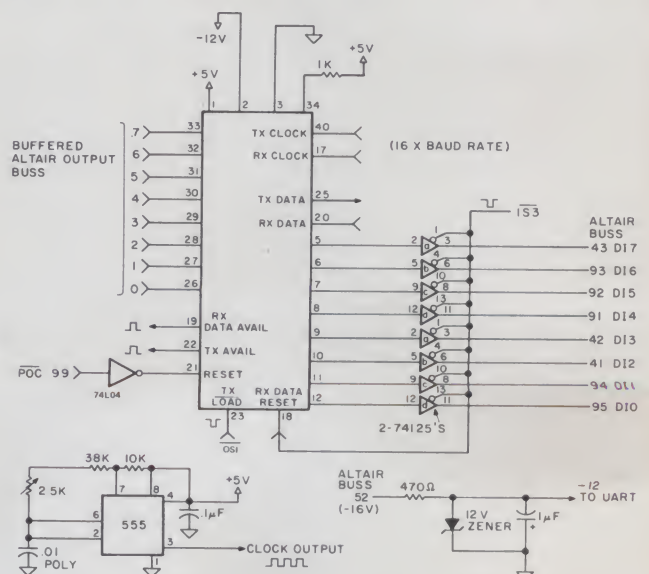
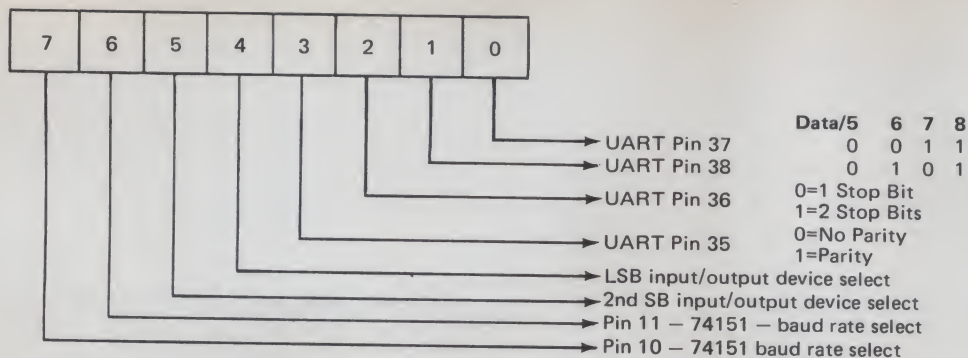


Fig. 10. UART Interface circuit. Labels and pin numbers reflect Altair bus. See text and Fig. 12 for connections of Pin 35-39.

Power	+5	-12	Gnd
TMS-6011	1	2	3



Control Word Format (suggestion only)

In this proposal bits 4 & 5 control the selection of both the input device and the output device. If you really need this versatility plus independent input/output selection, consider the use of a second control port.

Fig. 13. Suggestion for possible use of a control port to control baud rate, format and Input/Output of the UART.

Status Port —
Input Port 0 —
Bit Assignments
0 — UART Data Available if Low
1 — Keyboard Data Available if Low
2 —
3 —
4 —
5 —
6 —
7 — UART Transmitter available if Low
Output Port 0 — Reserved for Control port.
Input Port 1 — UART Input
Output Port 1 — UART Output
Input Port 3 — Keyboard Input
Output Port 3 — Digital Group Video Display

Table 1. System Port assignments.

	1	2	3	4	5	6	7
	K	B					
8	C	A	L	E	N	D	A

Mr. Alton C. Smith of Conyers GA was the winner of an 8K Static Memory Card from Seals Electronics in their "count the chip clips" contest held in Atlanta. His guess was 12,329; total number of chip clips in the container was 12,377.

CORRECTIONS

On page 13 of the August 1977 issue of *Kilobaud*, the Vertel Kilobyte credit card system was mentioned. Since information on the system appeared, we have had several inquiries as to Vertel's address. For anyone else who's curious, that address is: Vertel, 167 Worcester Street, Wellesley Hills MA 02181.

be changing the format often. That leaves pins 35 through 39 for you to program. Generally, parity sense won't change so you may hardwire pin 3 to either low or high depending on whether you want odd or even parity.

If you desire to omit parity entirely then hardwire pin 35 to high. Pin 36 gives you the desired number of stop bits — 1 if low and 2 if high. Pins 37 and 38 together decide how many data bits are to be sent or received and this ranges from 5 to 8. If both 37 and 38 are low then a 5-bit data word is formatted; 37 low and 38 high gives you 6 data bits; 37 high and 38 low gives 7 data bits and if both 37 and 38 are high you get an 8-bit data word. See Figs. 12 and 13 for formatting chart which illustrates the application of some of these ideas. If you are using parity remember; parity adds one bit to the data word. Also when using this technique you must initialize your control port with the proper baud rate, data word format and device select prior to use.

So there you have it. A collection of diagrams, tables, conventions and thoughts which can be the basis for building an I/O board to suit your system. You can put as much or as little into it as you want to. Happy wrapping! ■

about the same time (30 nanoseconds or so maximum time lag). Neat and simple. The format of the data word may also be changed under software control.

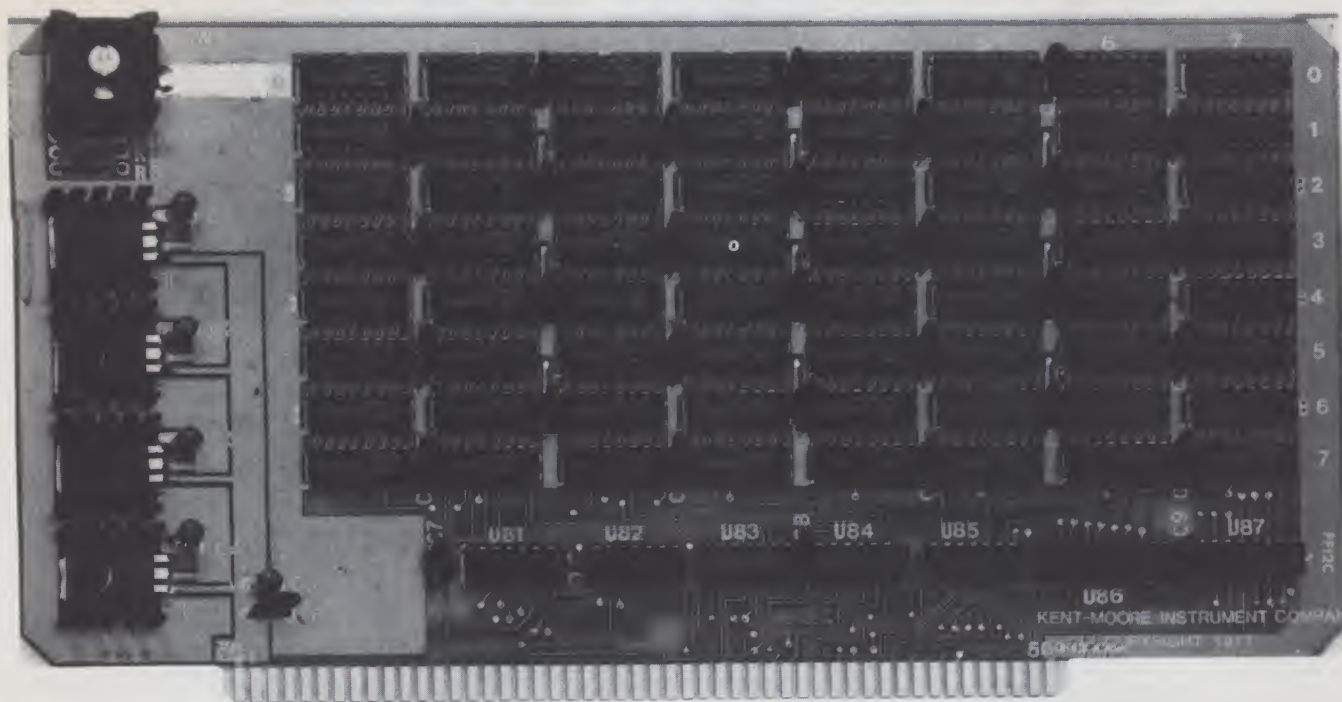
If you are going to use the serial port to communicate with a cassette interface, a modem and a Baudot Teletype (or an ASCII Teletype for that matter) you will have to adjust the format of the data word used by the UART somehow.

Using software and a control port sure beats lifting the lid and changing jumpers and it's a lot faster too! For this you will be interested in pins 34 thru 39 of your UART. Pin 34 must be high to enable the formatting of the UART. You may wish to hardwire this to +5 (through a 1k ohm resistor) or use a bit from your control port. Seems a bit wasteful (no pun intended) to tie up a bit from the control port for this when you intend to program the UART by software and will

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1	74LS138	1.75
1	8212	4.50
1	TMS-6011	12.00
1	NE555	.60
9	14 pin wire-wrap soc.	3.24
2	16 pin wire-wrap soc.	.76
1	24 pin wire-wrap soc.	1.00
1	40 pin wire-wrap soc.	1.75
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Table 2. Parts (and cost) list.

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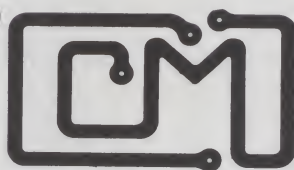
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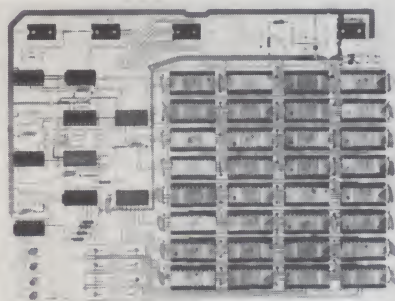
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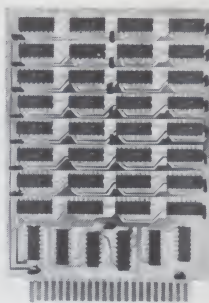
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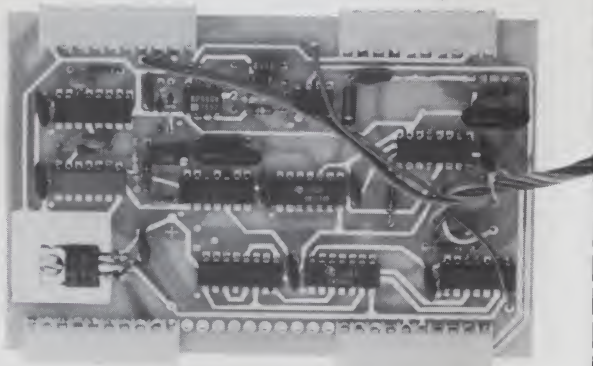
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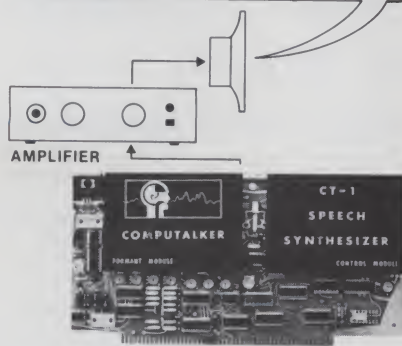


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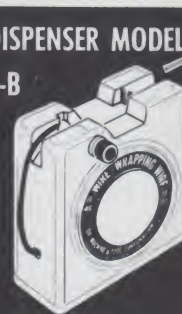
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For Sale: Dual ICOM floppy system, rack mounted. See pix, p. 16 KB #4. 22 s. motherboard, ICOM PS and controller — \$2700. Gene Christianson, Box 267, Santa Barbara CA 93102 (805) 966-6303.

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For Sale: Classic Fairchild F-8 micro evaluation system. Includes F-8 micro, memory controller, 1 KB RAM, address and data switches and LEDs, and complete control system. All on one large board — requires +5 and -12 V dc. Includes TTY interface and I/O routines on PROM. Original price \$800 it's yours for \$500. Perfect shape. J. Molnar, Box 225, Greenfield NH 03047 (603) 547-2035, after 5.

THIS is a \$5 ad. If desired, ads may cross a \$5 or \$10 boundary. Rates increase in \$5 increments only. Be sure to enclose sufficient payment!

Here is the latest new service for Kilobaud readers! Effective this month, KB will accept and publish classified advertisements for computer hobbyists. This service should help you unload any used gear you have lurking around — it's nice to have a few extra bucks to purchase something new! Ads are for computer gear only ... *no commercial advertisements, please*. The cost for this service is \$5 or \$10, depending on the box you purchase. Refer to specific details in the box above the first ad.

A word about deadlines — as you know, KB is dated to arrive at the beginning of the cover month. If you want your ad in a specific issue, we need 60 days to process it. If you simply want your copy to appear in the next KB, make sure your ad is in our hands by the first of the month. You can help make your ad accurate. Remember, typesetters are not computer professionals ... they don't know what a 256x8 UV PROM is, so give Barbie, Marie, Sandy, and Pauline a break! Type your ad, or at least print neatly in upper and lower case letters. We will do our best from there! Happy selling! (Since we had to start this thing somewhere, we are illustrating "Kilobaud Classified" ads by providing three live wires. Do these people a favor and flood them with offers for their gear! — KB staff.

HAVE you seen the new selections in the "KB Book Nook?" Check it out — perhaps you'll find a title you need for your collection!

Have you seen 73 Magazine yet? Each month's issue contains an I/O computer section, as well as articles for all electronic enthusiasts. Subscribe today — you won't regret it. 73 Magazine, Peterborough NH 03458.

LETTERS

from page 19

from SWTPC within five days after I sent the initial letter.

The second problem was that the PR-40 would not function properly with the SWTPC editor assembler program. The IRQ/NMI jumpers must be removed from the parallel interface card. SWTPC answered this letter within one week. I'm very impressed with response time like this, considering how busy they must be. A one week response time by mail is excellent, since Texas is half way across the country from California.

Clayton W. Abrams
San Jose CA 95124

Copyrights, Royalties, Licenses?

I have a question for Kilobaud: I'm about to enter a new area for me — that of systems programming — and I'm somewhat confused about the legal aspects of it. I have no intention of coming up with an operating system completely from scratch. I intend to incorporate the best ideas that I've seen in DDJ, KB, and Byte over the last two years along with some of my own. My question is — will it be mine to sell when I get done? Can I use routines and subroutines verbatim if they've been published? If not, how much modification must I do to make them mine? If I use public routines inside of my own package, do I have a copyright on the package? If I use factory-furnished device drivers do I have to negotiate royalties with them (a little ridiculous if I only sell 20 copies)?

Since this project will require quite a bit of work, trial and error, and wheel reinventing, I'd like to be

able to sell a few copies after I get it debugged and working.

I'd appreciate any opinions, facts, experiences you could give me (via KB?) because I want to do it legally and correctly if possible. Perhaps some copy-right lawyer would be interested in writing an article detailing what our legal responsibilities are in this field.

Verlynn J. Johnson
Storm Lake IA 50588

The KB Legal/Business Forum will be addressing these and other questions in upcoming issues. — John.

Contest!

To All Kilobaud Readers:

As you devour the pages of the latest issue of Kilobaud do you find a particular program that strikes you, for whatever reasons, as better than the rest? If so, turn to the Reader Service card at the back of the magazine and find the title page number of the article in which the program appears. Check the page number and send the card our way. Author of the program receiving the most votes each month will win \$100.

At the end of the year, monthly winners will compete for a \$500 prize for best program of the year.

And that's not all! There will also be a prize drawing of all cards submitted by voters. (More details in the next issue.)

So ... when you've finished reading Kilobaud from cover to cover, select the program you think is best, check it on the survey card and drop the card in the mail.

PS. Please send cards early so we can compile them in time to meet our deadlines.

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Manufactured by one of California's leading aerospace contractors. Because of the discount price we have agreed not to publish the manufacturer's name.

Includes batteries, jewelry case and 18-month factory warranty.

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ELECTRONIC ENTERTAINMENT CENTER

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Color \$24.88

TELETYPE MODEL 43

New from Teletype, the Model 43 is capable of printing 132 ASCII characters per line. Send and receive data at 10 or 30 words per second. Keyboard generates all 128 ASCII code combinations. RS-232 interface, same as the popular Model 33. Data sheet sent upon request. Manufacturer suggested price \$1377.00, telephone for discount and availability.

We also have for sale a limited quantity of used Model 35's. Priced at only \$449.50



HEXADECIMAL KEYBOARD

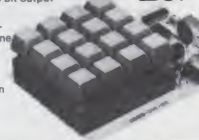
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Requires single + 5 volt supply.

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CONNECTORS

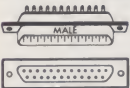
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RS-232

DB25P male plug & hood

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100 PIN

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This joystick feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Perfect for television games, quad stereo and radio controlled aircraft.

FREE

MANUAL GRAPHITE DISPLAY GENERATOR

Modern technology has pioneered the development of this unique character printer. Our Manual Graphite Display Generator has the capability of producing the full upper and lower case ASCII set. Self-contained cursor assembly allows the operator to eliminate erroneously entered information. Each unit is manufactured to strict tolerances as prescribed by standards set forth by California Industrial. One free with every order.

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10 for \$45. DISKETTES

3M IBM 3740 series and compatible drives



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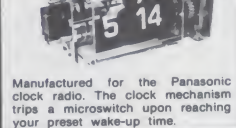
Ideal for keyless entry systems, burglar alarms, Touch Tone or hexadecimal computer input code.



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Manufactured for the Panasonic clock radio. The clock mechanism trips a microswitch upon reaching your preset wake-up time.



2708

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8K UV Erasable MEMORY



SUPREMACY

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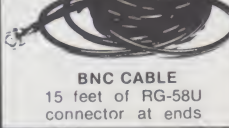
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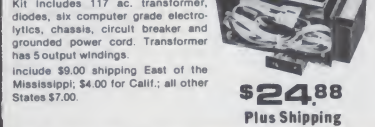
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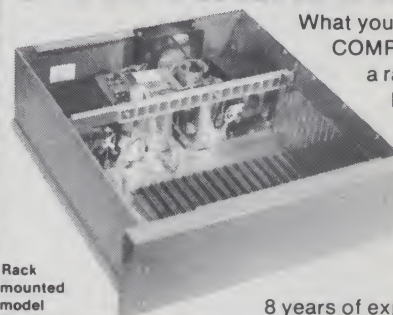
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2912	21.95	7413N	45.15	74149	45	74394	79	74S27	44
2913	7.95	7414N	69.15	74150	75	74395	79	74S28	44
2914	29.95	7415N	35.15	74151	1.29	74396	79	74S29	44
2915	29.95	7416N	35.15	74152	1.29	74397	79	74S30	44
2916	14.95	7417N	35.15	74153	1.29	74398	79	74S31	44
2917	14.95	7418N	35.15	74154	1.29	74399	79	74S32	44
2918	14.95	7419N	35.15	74155	1.29	74400	79	74S33	44
2919	14.95	7420N	35.15	74156	1.29	74401	79	74S34	44
2920	14.95	7421N	35.15	74157	1.29	74402	79	74S35	44
2921	14.95	7422N	35.15	74158	1.29	74403	79	74S36	44
2922	14.95	7423N	35.15	74159	1.29	74404	79	74S37	44
2923	14.95	7424N	35.15	74160	1.29	74405	79	74S38	44
2924	14.95	7425N	35.15	74161	1.29	74406	79	74S39	44
2925	14.95	7426N	35.15	74162	1.29	74407	79	74S40	44
2926	14.95	7427N	35.15	74163	1.29	74408	79	74S41	44
2927	14.95	7428N	35.15	74164	1.29	74409	79	74S42	44
2928	14.95	7429N	35.15	74165	1.29	74410	79	74S43	44
2929	14.95	7430N	35.15	74166	1.29	74411	79	74S44	44
2930	14.95	7431N	35.15	74167	1.29	74412	79	74S45	44
2931	14.95	7432N	35.15	74168	1.29	74413	79	74S46	44
2932	14.95	7433N	35.15	74169	1.29	74414	79	74S47	44
2933	14.95	7434N	35.15	74170	1.29	74415	79	74S48	44
2934	14.95	7435N	35.15	74171	1.29	74416	79	74S49	44
2935	14.95	7436N	35.15	74172	1.29	74417	79	74S50	44
2936	14.95	7437N	35.15	74173	1.29	74418	79	74S51	44
2937	14.95	7438N	35.15	74174	1.29	74419	79	74S52	44
2938	14.95	7439N	35.15	74175	1.29	74420	79	74S53	44
2939	14.95	7440N	35.15	74176	1.29	74421	79	74S54	44
2940	14.95	7441N	35.15	74177	1.29	74422	79	74S55	44
2941	14.95	7442N	35.15	74178	1.29	74423	79	74S56	44
2942	14.95	7443N	35.15	74179	1.29	74424	79	74S57	44
2943	14.95	7444N	35.15	74180	1.29	74425	79	74S58	44
2944	14.95	7445N	35.15	74181	1.29	74426	79	74S59	44
2945	14.95	7446N	35.15	74182	1.29	74427	79	74S60	44
2946	14.95	7447N	35.15	74183	1.29	74428	79	74S61	44
2947	14.95	7448N	35.15	74184	1.29	74429	79	74S62	44
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2949	14.95	7450N	35.15	74186	1.29	74431	79	74S64	44
2950	14.95	7451N	35.15	74187	1.29	74432	79	74S65	44
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2952	14.95	7453N	35.15	74189	1.29	74434	79	74S67	44
2953	14.95	7454N	35.15	74190	1.29	74435	79	74S68	44
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2957	14.95	7458N	35.15	74194	1.29	74439	79	74S72	44
2958	14.95	7459N	35.15	74195	1.29	74440	79	74S73	44
2959	14.95	7460N	35.15	74196	1.29	74441	79	74S74	44
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2983	14.95	7484N	35.15	74220	1.29	74465	79	74S98	44
2984	14.95	7485N	35.15	74221	1.29	74466	79	74S99	44
2985	14.95	7486N	35.15	74222	1.29	74467	79	74S00	44
2986	14.95	7487N	35.15	74223	1.29	74468	79	74S01	44
2987	14.95	7488N	35.15	74224	1.29	74469	79	74S02	44
2988	14.95	7489N	35.15	74225	1.29	74470	79	74S03	44
2989	14.95	7490N	35.15	74226	1.29	74471	79	74S04	44
2990	14.95	7491N	35.15	74227	1.29	74472	79	74S05	44
2991	14.95	7492N	35.15	74228	1.29	74473	79	74S06	44
2992	14.95	7493N	35.15	74229	1.29	74474	79	74S07	44
2993	14.95	7494N	35.15	74230	1.29	74475	79	74S08	44
2994	14.95	7495N	35.15	74231	1.29	74476	79	74S09	44
2995	14.95	7496N	35.15	74232	1.29	74477	79	74S10	44
2996	14.95	7497N	35.15	74233	1.29	74478	79	74S11	44
2997	14.95	7498N	35.15	74234	1.29	74479	79	74S12	44
2998	14.95	7499N	35.15	74235	1.29	74480	79	74S13	44
2999	14.95	7500N	35.15	74236	1.29	74481	79	74S14	44
3000	14.95	7501N	35.15	74237	1.29	74482	79	74S15	44
3001	14.95	7502N	35.15	74238	1.29	74483	79	74S16	44
3002	14.95	7503N	35.15	74239	1.29	74484	79	74S17	44
3003	14.95	7504N	35.15	74240	1.29	74485	79	74S18	44
3004	14.95	7505N	35.15	74241	1.29	74486	79	74S19	44
3005	14.95	7506N	35.15	74242	1.29	74487	79	74S20	44
3006	14.95	7507N	35.15	74243	1.29	74488	79	74S21	44
3007	14.95	7508N	35.15	74244	1.29	74489	79	74S22	44
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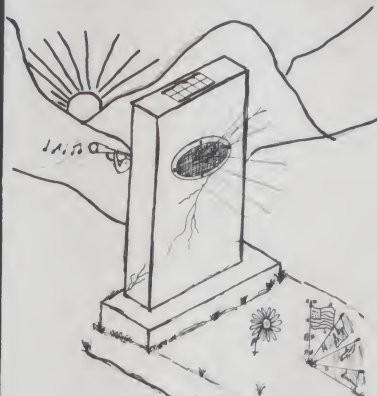
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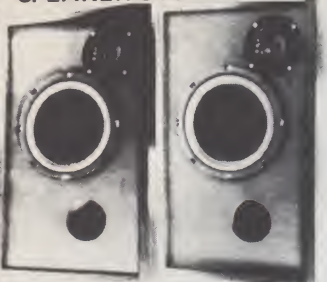
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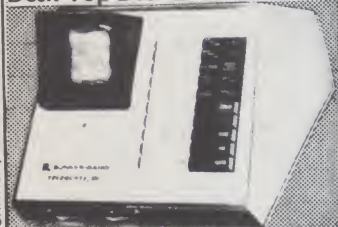
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Save \$100!... 10 kits for \$599.00
CABINETS Only: Sh. Wt. 30 Lb. 70B70197... \$25.00/pair

Desk Top DISPLAY STATION

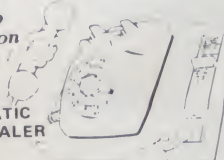


At one time these data terminals were used by stock brokers for keeping track of stock quotations. They tied in to a central system which has now been updated, leaving these surplus units behind. Use this unit as a basis for building your own computer input/output station or to build a compact scope... or simply take it apart for the components within. Sold complete or in parts, prices and descriptions listed below:
† 3" CRT, with Hi-volt. supply (+3315 vdc; -1730 vdc), and low-volt. supply +440V; +225V; +125V; +28V; +1.2V; +0.6V; 6.3VDC; 6.3VAC. Also - ramp generator card & some drive circuits (15 Lbs.)... \$17.50
† 50 key Block keyboard, with diode matrix on 2 cards (5 Lbs.)... \$12.50
† Handsome desk-top, slope front case, suitable for up to an 11" CRT, overall 10 1/2" x 16 1/2" x 9 1/2" (10 Lbs.)... \$7.50
† Plus: 3 wire line cord, brown, 7' lg for \$1.00; 14 wire connector cable for \$2.50.
† COMPLETE UNIT Sh. Wt. 35 Lbs. 6NB60336... \$29.95
† Also available is a complete tech. manual covering operating procedure, theory disassembly (& reassembly), troubleshooting techniques and schematics. With complete unit - \$1.00 or sold separately for \$3.50 each. Sh. Wt. 8 oz.
WHEN ORDERING:
Specify part, use order no. 6NB60336

"THE NAME CALLER"

Stores up to 38 phone numbers

AUTOMATIC PHONE DIALER



Here's a neat item, brand new and packaged surplus. Great for business, home, baby sitters, people confined to beds, emergencies... or just as a convenience. Keep all your most-often-called numbers in memory at all times. Two models available: Home 2001 and Business 3001. (Business 3001 has 40 pin connector for multi-line phones). Sh. Wt. 12 Lbs. Home 2001... 7ZU70265... \$28.88
Business 3001... 7ZU70266... \$38.88

KEY-TO-MAGNETIC TAPE RECORDER



Singer/Perfec systems with display station, keyboard, 7 track magnetic data recorder, controller, etc. Singer closes out its computer products division and these units become surplus! Their loss (\$460x106) is your gain... you can buy this super recorder for pennies on a dollar. They are late design models of recent mfg., and are still being serviced with

backup. Unit has internal memory/buffer for 80 or 200 character storage. Units show character, character no., and record no. Read back circuits allows search on record key, editing, duplicating, etc. Units were working when taken out of service and are complete & ready-to-go, but may require minor adjustments. Sold on an "AS IS" basis only. Manuals not supplied with unit, available separately. Size: 19"H x 21 1/4"W x 19 1/4"D. Tape not supplied.

We have 2 types available:

Md. 4301-7 7-track Data Recorder, our catalog no. 7SF70296... \$218.88
Complete Manual... 7SF70296-M... \$28.50
Md. 4311-7 7-track Data Recorder with remote data communication channel, our catalog no. 7SF70297... \$248.88
Complete Manual... 7SF70297-M... \$28.50
(Manuals weigh 3 Lbs.)

All Magnetic Tape Data Recorders are shipped via truck, freight collect to you. Customer pays shipping.

Model 52 LINE PRINTERS - \$650.00 ea.

Computer surplus close-out on Singer-Friden Md. 52 line printer. 100 lines per minute with 132 characters per line max. The printer is connected to a system computer through an input/output channel and may be located up to 2,000 wire-feet from computer using a 2-wire line. Uses standard continuous paper forms, with up to 5 copies and 1 original. Power: 115V, 60 Hz; 6 amps. Size: 30"W x 27"Dp x 38"H.

These units were working & going units when taken out of service. Shipped only on an "AS IS" basis. You should be able to put these on line with a minimum of work, and then you have a \$3,600 line printer working for you at less than 1/5 the cost. Shipped via truck freight collect to you, F.O.B. Peabody, Ma. 01960. 7SF70298... \$650.00

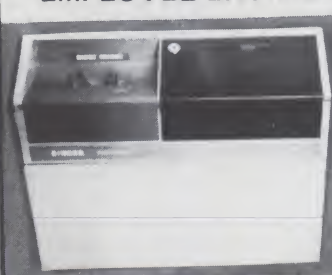
DATA MANUALS, while they last... 7SF70298-M... \$45.00

**Also available are a few damaged units, which have broken glass covers. Damage appears to be cosmetics only. Save \$100. 7SF70299... \$550.00



Singer-Friden
Md. 52 Line Printer

EMPLOYEE ENTRANCE STATION SYSTEM



This unique system for verification of entering employees is made up of modular components, each of which is useful separately. You can buy just the part you need, or purchase an entire system for your own uses and/or education. Capable of tie-in to an external printer. Size: 20 1/2"W x 23" x 6 1/2".

TOUCH-TONE GENERATOR CHIP

New, 2 of 8 encoder chip ME8900, (similar to the MC14410). Sold with data sheet on uses of MC14410 chip. No crystals required. Sh. Wt. 8 oz. 7VL70160... \$6.95 ea... \$60.00 for 10

POSTAGE: Please add sufficient funds for postage and insurance. Shipping weight for merchandise is listed at the end of each product description. All shipping is from Peabody, Ma. 01960. Mass. Residents Add 5% Sales Tax.

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The system contains the following modular sections:

- Badge Reader with power supply, Holther coded - but comes out ASCII. Input 110 V, 60 Hz. Sh. Wt. 15 Lbs. 7SF70295-A... \$25.00
 - Modular Power Supply O.F. +5V, 3A; ±12V, 25A; +24V, 5A. 10 Lbs. 7SF70295-B... \$19.50
 - Modular Memory Stack, with drivers etc. 512 x 6, requires 24V input. 5 Lbs. 7SF70295-C... \$17.50
 - Central Processor for above memory. 5 Lbs. 7SF70295-D... \$25.00
 - Hi Voltage Power Supply for plasma display (below) 5 Lbs. 7SF70295-E... \$10.00
 - 4 Digit Display on front panel 3 Lbs. 7SF70295-F... \$10.00
 - Time Clock for badge reader, etc. 5 Lbs. 7SF70295-G... \$10.00
 - Key Switch SPST 8 oz. 7SF70295-H... \$2.00
 - Complete Unit (Used)* 7SF70295-J... \$69.88
 - Complete Unit (New)* 7SF70295-K... \$88.50
- * Complete units weigh in excess of 75 pounds and must be shipped via truck freight collect to you.

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New solid state color TV chassis and parts for use with In-Line black matrix picture tubes. Features include one button color tuning AFC and low power consumption.

We have two chassis types, the TS951 (for 13 & 15") and the TS953 (for 19").

To build a complete 19" TV these parts must be added: UHF & VHF tuners, picture tube, tube shield, purity magnets, antenna, yoke, speaker, on-off switch, 4-10K pots, binding posts & case. To build a 13" or 15" TV you'll have to add: picture tube, tube shield, yoke, purity magnets, antenna, 2nd stage hi-voltage boost, binding posts & case (chassis has tuners).

We do not offer a complete parts package, but we do include full tech. training manual, and we have some parts available.

These chassis are new & guaranteed.

Price List Sh. Wt. 12 Lbs. each.

13" TV Chassis (w/tuners & controls) 6Z60175... \$49.50
15" TV Chassis (w/tuners & controls) 6Z60174... \$49.50
19" TV Chassis (no tuners, no controls) 6Z60172... \$29.50
VHF Tuner (for 19")... 6Z60303... \$8.50
UHF Tuner (for 19")... 6Z60304... \$2.50
Antenna Telescope... 5M100419... \$1.50
Binding Post Assy... 4M100422... \$1.50

ALSO.....

We have found some of the same model "TV" chassis that have been damaged, most with bent frames or cracked P.C. boards. They are sold "AS IS", at low, low prices. Parts are worth 5X as much. All sales final. Sh. Wt. 12 Lbs. each.

13" Chassis... 7DZ70059... \$22.50
15" Chassis... 7DZ70060... \$22.50
17" Chassis... 7DZ70061... \$14.88
19" Chassis... 7DZ70062... \$14.88

TV to MONITOR INTERFACE KIT

TV game board allows interface of any TV as a video monitor for computer use. With power supply & data for 300/75 ohm. Home brew money-saver! 3 Lbs. 7ZU70213... \$5.00 ea... \$27.88 for 5



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- TV TENNIS, Kit form, AS IS. 5 Lbs. 7HU70250... \$8.88... 4 for \$28.88

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This regulated power supply has outputs of ±15 volts at 0.25 amps and ±5 volts at 2.5 amps, with an input of 115 VAC. Manufactured by a computer company as part of a phone data terminal. Three (3) 723's (IC's) are used for voltage regulation. Units have barrier strip outputs, and are open frame. Size: 5" x 9" x 2". New surplus. Qty. Ltd. Sh. Wt. 5 Lbs... 6M160215... \$17.50
3 for \$45.00... 6M160215... \$45.00/3

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★ Imsai - Altair "A" Compatible Kits ★

Z-80 CPU KIT COMPLETE - \$149. kit

Z-80 Chip & Manual \$49.95

Z-80 Manual - \$7.50 Separately

From the same people who brought you the \$89.95 4K RAM KIT. We were not the first to introduce an Imsai/Altair compatible Z-80 Card, but we do feel that ours has the best design and quality for the lowest price!
The advance features of the Z-80 such as an expanded set of 158 instructions, 8080A software compatibility, and operation from a single 5VDC supply, are all well known. What makes our card different is the extra care we took in the hardware design. The CPU card will always stop on an M1 state. We also generate TRUE SYNC on card, to insure that the rest of your system functions properly. Dynamic memory refresh and NMI are brought out for your use. Believe it or not, not all of our competitors have gone to the extra trouble of doing this.
As always this kit includes all parts, all sockets, and complete instructions for ease of assembly. Because of our past experience with our 4K kit we suggest that you order early. All orders will be shipped on a strict first come first served basis. Dealers inquiries welcome on this item. Kit includes Zilog Manual and all parts. Kit shipped with 2 MHz crystals.

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WORKS

\$89.95

4K LOW POWER RAM BOARD KIT

Imsai and Altair 8080 plug in compatible. Uses low power static 21L02-1 500 ns. RAM'S. Fully buffered, drastically reduced power consumption, on board regulated, all sockets and parts included. Premium quality plated through PC Board.

For 250 ns RAM's add \$10.00

NEW! DESIGN CONSOLETT KIT - \$89.95

S.D. Sales announces the inexpensive way to beat the wire wrap jungle. Our latest kit gives you 124 solderless quick connect terminals, enough for eight 16 pin IC's and provides 50 x 8 common buss matrix. Has regulated +5VDC and +/- 15VDC, all at 1 AMP. Voltage regulation at 100%. Also includes a pulse generator variable from 10hz to 50mhz and .01 sec. to 100 nano seconds. Generator output is +5V. In kit form only and includes all parts, sockets; front panel measures 7 1/4" x 8 1/4", and hardware. case not available.

CAR/BOAT KIT *New Item!*

\$34.95

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Musical Horn Kit for car, boat, or home. Plays any tune from Mozart to Led Zeppelin. Change tunes in seconds; complete solid state electronics. Standard or custom tunes available at \$6.95 each (you supply us with the sheet music - we supply electronics for your favorite tune.) One song supplied with original order. Standard tunes available: DIXIE - EYES OF TEXAS - ON WISCONSIN - YANKEE DOODLE DANDY - NOTRE DAME FIGHT SONG - PINK PANTHER - AGGIE WAR SONG - ANCHORS AWAY - NEVER ON SUNDAY - BRIDGE OVER RIVER QUI - CANDY MAN.

HOME KIT

\$26.90

Home kit includes speaker which operates from your door bell. When door bell is pushed your favorite tune is played. Car/boat kit DOES NOT include speaker. Uses standard 8ohm PM speaker. Allow 4 weeks delivery on both kits.

Limited Quantity!

\$9.95 kit

6 DIGIT ALARM CLOCK KIT

We made a fantastic kit even better. Redesigned to take advantage of the latest advances in IC technology. Features: Litronix Dual 1/2" displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Greatly simplified construction. More reliable and easier to build. Kit includes all necessary parts (except case). For P.C. board add \$3.00; AC XFMR add \$1.50. Do not confuse with Non-Alarm kits sold by our competition! Eliminate the hassle - avoid the 5314!

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Not only are our RAM'S faster than a speeding bullet but they are now very low power. We are pleased to offer prime new 21L02-1 Low Power and Super Fast RAM'S. Allows you to STRETCH your power supply farther and at the same time keep the wait light off!

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Gen. Purpose D.I.P.
Boards with Bus Pattern
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Epoxy Glass 1/16" 44
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With Rechargeable Batteries & Charger Unit
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settings. ± 3%.
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The spooled wire passes through the tool past a slitting edge
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when the sharp edge



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Just plug in any component with leads to .022" dia. holes
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for .042 dia. holes
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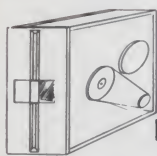
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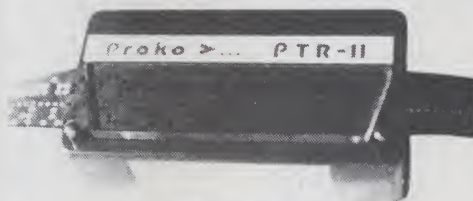
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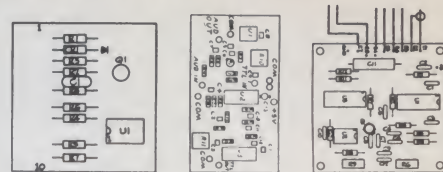
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- **Rolling Zeros**—This Bearcat exclusive tells you which channels your scanner is monitoring.
- **Tone By-Pass**—Scanning is not interrupted by mobile telephone tone signal.
- **Manual Scan Control**—Scan all 10 channels at your own pace.
- **3-Inch Speaker**—Front mounted speaker for more sound with less distortion.
- **Squelch**—Allows user to effectively block out unwanted noise.
- **AC/DC**—Operates at home or in the car.

Bearcat® 210 Specifications

Frequency Reception Range

Low Band	32—50 MHz
"Ham" Band	146—148 MHz
High Band	148—174 MHz
UHF Band	450—470 MHz
"T" Band	470—512 MHz

* Also receives UHF from 416—450 MHz

Size

10 $\frac{1}{2}$ " W x 3" H x 7 $\frac{1}{8}$ " D

Weight

4 lbs. 8 oz.

Power Requirements

117V ac, 11W; 13.8 Vdc, 6W

Audio Output

2W rms

Antenna

Telescoping (supplied)

Sensitivity

0.6 μ v for 12 dB SINAD on L & H bands

U bands slightly less

Selectivity

Better than -60 dB @ \pm 25 KHz

Scan Rate

20 channels per second

Connectors

External antenna and speaker; AC & DC power

Accessories

Mounting bracket and hardware
DC cord

The Bearcat® 210 is a sophisticated scanning instrument with the ease of operation and frequency versatility you've dreamed of. Imagine, selecting from any of the public service bands and from all local frequencies by simply pushing a few buttons. No longer are you limited by crystals to a given band and set of frequencies. It's all made possible by Bearcat spaceage solid state circuitry. You can forget crystals forever.

Pick the 10 frequencies you want to scan and punch them in on the keyboard. It's incredibly easy. The large decimal display reads out each frequency you've selected. When you want to change frequencies, just enter the new ones.

Automatic search lets you scan any given range of frequencies of your choice within a band. Push-button lockout permits you to selectively skip frequencies not of current interest. The decimal display with its exclusive "rolling zeros" tells you which channels you're monitoring. When the Bearcat 210 locks in on an active frequency the decimal display shows the channel and frequency being monitored.

With the patented track-tuning system, the Bearcat 210 automatically aligns itself so that circuits are always "peaked" for any broadcast. Most competitive models peak only at the center of each band, missing the frequencies at the extreme ends of the band.

The Bearcat 210's electronically switched antenna eliminates the need for the long low band antenna. And a quartz crystal filter rejects adjacent stations as well as noise interference.

Call toll-free 800-521-4414 now to place a BankAmericard or Mastercharge order. This is our 24 hour phone to our order department and only orders may be processed on this line. To order in Michigan or outside of the U.S. dial 313-994-4441.

Add \$5.00 for U.S. shipping or \$9.00 for air UPS to west coast. Charge cards or money orders only please. International orders invited. Michigan residents add tax. Please write for quantity pricing.

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C5



High quality sockets for IC's and PC interconnections. Check our prices and quality- you will see why TRI-TEK is fast becoming the leader in IC sockets.

Low Profile DIP Solder Tail (Tin)
End/Side stackable on .100" centers

	1-9	10-24	25-100
SKT-0802 8 pin	.15	.15	.14
1402 14pin	.18	.17	.16
1602 16pin	.20	.19	.18
1802 18pin	.27	.26	.25
2002 20pin	.29	.28	.27
2202 22pin	.35	.34	.33
2402 24pin	.36	.35	.34
2802 28pin	.42	.41	.40
4002 40pin	.60	.57	.53

3 Level Wire Wrap Gold

	1-9	10-24	25-100
SKT-1400	.38	.37	.36
1600	.42	.41	.40
1800	.73	.65	.59
2400	1.00	.91	.83
4000	1.69	1.51	1.37

RIBBON CABLE IC INTERCONNECTS

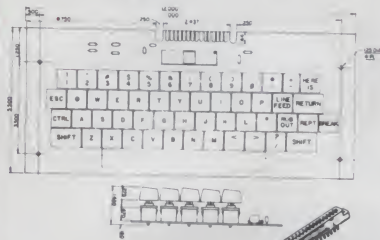
No. Of Pins	SINGLE END				
	6"	12"	18"	24"	36"
14P	1.51	1.62	1.72	1.83	2.05
16P	1.64	1.76	1.87	1.99	2.21
24P	2.49	2.69	2.88	3.08	3.48
No. Of Pins	DOUBLE END				
	6"	12"	18"	24"	36"
14P	2.76	2.87	2.97	3.08	3.30
16P	3.01	3.13	3.24	3.36	3.58
24P	4.55	4.75	4.94	5.14	5.54



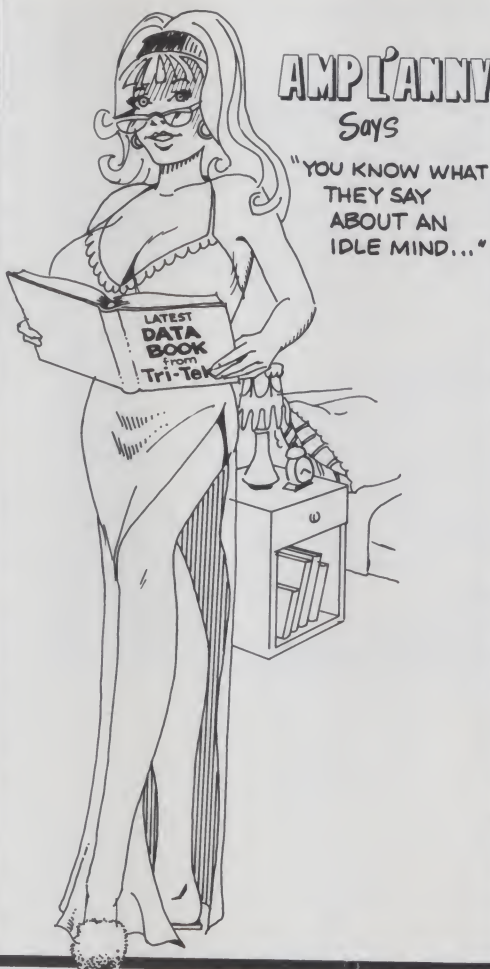
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Check these professional features:

- ☆ 53 Keys, popular ASR-33 format!
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- ☆ MOS DTL TTL Compatible outputs!
- ☆ Upper Case lockout!
- ☆ Data and Strobe inversion option!
- ☆ Low contact bounce!
- ☆ Selectable Parity!
- ☆ Custom Keycaps!
- ☆ Three User Definable Keys!
- ☆ MORE!



Model 753 Keyboard (with free connector!).....\$59.95



AMPLANNY Says

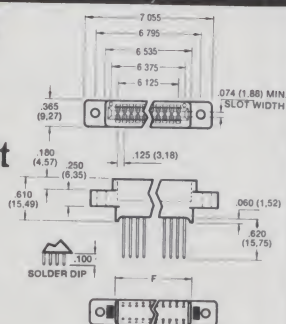
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2 X 50, .125"

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HIGH QUALITY DUAL 50 PIN EDGE CONNECTORS. For use in the IMSA[®], VECTOR and other machines with the .25" row spacing. Its' body is high temperature polyester and will not chip, crack or flake even after heating. Can be pop-riveted without cracking as phenolic parts will. End standups allow for flow to top side and visual inspection. Offset mounting ears allow proper mounting on those machines with side rails.

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PCC-100WW-G....(Gold, 3 level wire-wrap).....	\$4.50, 4/\$17.00
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Snap-In Card Guide, 4 1/2" Molded Nylon. 50¢ pr, 10 pr/\$4.50

MM57109 MOS/LSI Number-Oriented Microprocessor

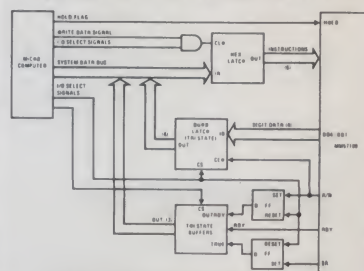


FIGURE 131a MM57109 as a Microprocessor/Microcomputer Peripheral

The MM57109 is an MOS/LSI number oriented microprocessor intended for use in number processing applications. Scientific calculator functions, test and branch capability, internal number storage, and input/output instructions have been combined in this single chip device. Programming is done in calculator keyboard level language with software development simplified and generated code more reliable because algorithms are preprogrammed in an on-chip ROM. Data or instructions can be synchronous or asynchronous; I/O digit count, I/O notation mode, and error control are user programmable; a sense input and flag outputs are made available for single bit control.

MM57109 can be used as stand alone processor with external ROM/PROM and program counter. Alternatively it can be configured as a peripheral device on the bus of a micro processor or minicomputer.

FEATURES:

- *Scientific calculator instructions (RPN)
 - Up to 8-digit mantissa, 2-digit exponent
 - Four-register stack, one mem register
 - Trig and Log functions, Y^X, e^X, pi, etc.
 - Error flag generation and recovery

*Flexible I/O

- Hold for single stepping and async operation
- Asynchronous digit input with ready
- Multidigit I/O with F.P. or scientific
- Programmable mantissa digit count for I/O
- Sense input and flag outputs

*Branch Control

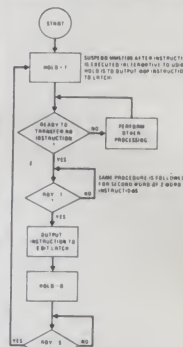
- Conditional and unconditional branching
- Increment/decrement branch on non-zero for program loops

*Interface Simplicity

- Single ϕ clock
- Low power operation
- Generation of I/O control signals
- Separate digit input, output, and address bus

Save memory space, increase algorithm speed, add to your BASIC or FORTRAN capabilities with this super number cruncher. Put it on your S-100 bus system and be ready for the new software packages coming out in the near future.

MM57109N.....with spec booklet.....\$21.92
Specs only for MM57109.....\$2.00



FUNCTION	MM57109
I/O	Multidigit asynchronous digit single bit
Data format	Floating point Scientific notation
Data length	Variable (1 to 8 digit mantissa)
Program	External ROM PC uP or F10
Speed (math or I/O operations)	0.5-400 ms
Minimum number of chips for CPU and RAM	1 (external PC and program source)

FIGURE 131b MM57109N Peripheral Interface



tri-tek, inc.

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WRITE and READ EPROM

1702A and 2708

- Plugs Directly into your ALTAIR/IMSAI Computer
- Includes Main Module Board and External EPROM Socket Unit
- The EPROM Socket Unit is connected to the Computer through a 25 Pin Connector
- Programming is accomplished by the Computer
- Just Read in the Program to be Written on the EPROM into your Processor and let the Computer do the rest.
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- Software included
- No External Power Supplies, Your Computer does it all
- Programs and Reads Both 1702A and 2708 EPROMS
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S29

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Altair/IMSAI compatible board catches program bugs and provides timing for real-time applications.

Four hardware breakpoint addresses. Software breakpoints only possible at instructions in RAM. Better Bug Trap breakpoints can be in ROM or RAM, and at data or instructions in memory, input/output channels, or stack locations.

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Unique interrupt structure: generates a CALL instruction to your subroutine anywhere in memory, not a RST!

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All this and more for about the price of a real-time clock board, but nothing else does the job of the Better Bug Trap.

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CARTERFONE MODEL 318 ASYNCH MODEM

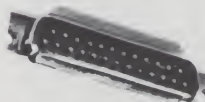
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RS232

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DEC LSI-11 COMPONENTS

All Items NEW

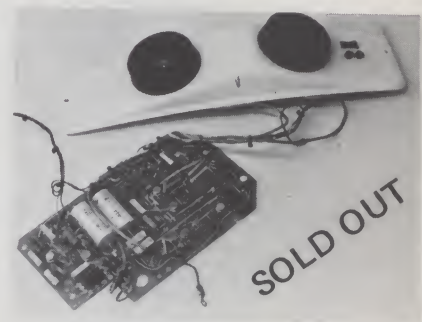
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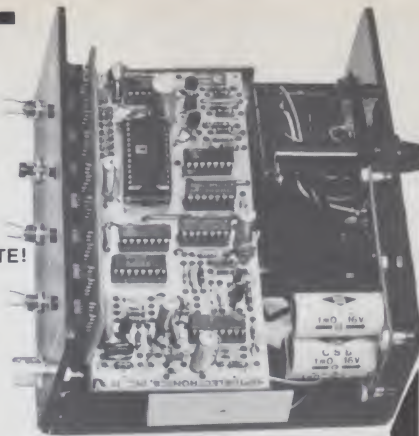
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KIT #PSL-650 650 MHZ PRESCALER [NOT SHOWN]
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\$119⁹⁵ COMPLETE!

SIZE:
3" High
6" Wide
5 1/2" Deep



FEATURES AND SPECIFICATIONS:
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GATE TIMES: 1 SECOND AND 1/10 SECOND
PRESCALER WILL FIT INSIDE COUNTER CABINET
RESOLUTION: 1 HZ AT 1 SECOND, 10 HZ AT 1/10 SECOND.
FREQUENCY RANGE: 10 HZ TO 60 MHZ. [65 MHZ TYPICAL].
SENSITIVITY: 10 MV RMS TO 50 MHZ, 20 MV RMS TO 60 MHZ TYP.
INPUT IMPEDANCE: 1 MEGOHM AND 20 PF.
[DIODE PROTECTED INPUT FOR OVER VOLTAGE PROTECTION.]
ACCURACY: ± 1 PPM [$\pm .0001\%$]; AFTER CALIBRATION TYPICAL.
STABILITY: WITHIN 1 PPM PER HOUR AFTER WARM UP [.001% XTAL]
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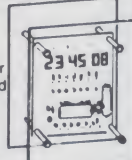
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Plexiglas is Pre-cut & drilled
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60 HZ.

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Will enable
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1"x2" PC Board
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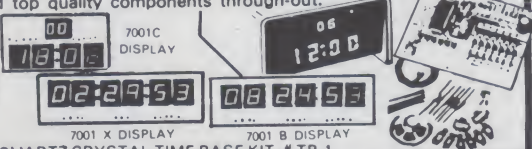
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FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM, SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

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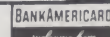
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3601	256 x 4 OC 70 ns	4.50	N8T97	Tri State Hex Buffer	1.45	CDP1802CD	CPU (RCA)	29.50
5203AO	256 x 8 Bit 1 us TS Erasable	7.00	DM8098	Tri State Hex Inverter	1.00	DYNAMIC RAMS		
5204AO	512 x 8 Bit 1 us TS Erasable	10.00	1488	RS232 Quad Line Driver	1.95	1103	1024 x 1 Bit 300 ns	1.50
82S23B	32 x 8 Bit 50 ns OC	4.00	3205	1-of-8 Decoder 18 ns Delay	6.20	2107B	4096 x 1 Bit 200 ns	4.50
82S129B	256 x 4 Bit 50 ns TS	4.25	D-3207A	Quad NAND to MOS Driver	2.50	2107B-4	4096 x 1 Bit 270 ns	4.00
8223B	32 x 8 Bit 50 ns OC	4.00	C-3404	6 Bit Latch 12 ns O/P Delay	3.95	4050NL	4096 x 1 Bit 300 ns	4.50
WAVE FORM GENERATOR			P-3408A	Tri State Hex MOS Sense Amp	6.75	4096	4096 x 1 Bit 300 ns	5.00
8038	VCO	4.50	P-4201	Clock Generator	4.95	MM5262	2048 x 1 Bit 365 ns	3.00
MC4024	Dual VCO	2.75	MM-5320	T V Camera Sync Generator	6.00	MM5270	4096 x 1 Bit 200 ns (18 Pin)	5.00
566	VCO-Function	2.00	MM-5369	Oscillator Pre-Scaler	2.00	5280	4096 x 1 Bit 200 ns (16 Pin)	6.00
CHARACTER GENERATORS			DM-8130	Ten Bit Comparator	2.25	STATIC RAMS		
2513	5x7 5 line Lower Case	6.75	DM-8131	6 Bit Comparator	2.35	21L02-1	1024 x 1 Bit 350 ns TS	1.58
2513	5x7 5 line Upper Case	6.75	DM-8831	4 Input AND NAND Tri State	2.50	31L01	16 x 4 Bit 110 ns OC	2.00
MCM6571	128 x 9 x 7 ASCII Shifted Greek	10.80	DM-8833	Quad Tri State Transceiver (True)	2.50	1101A	256 x 1 Bit 1 us TS	1.00
MCM6571A	128 x 9 x 7 Downcount	10.80	DM-8835	Quad Tri State Transceiver (Inv)	2.50	2101	256 x 4 Bit 1 us TS	3.00
MC6572	128 x 9 x 7 ASCII Non-Shifted W/G	10.80	UARTS			2102	1024 x 1 Bit 1 us TS	1.25
SHIFT REGISTERS			AY5-1013	(GI)	6.95	2102-1	1024 x 1 Bit 500 ns TS	1.50
1404AN	1024 x 1 Bit 2.5 MHz	3.00	TR-1602A	(WD)	6.95	2111A-4	256 x 4 Bit 450 ns TS (18 pin)	4.45
2505K	512 x 1 Bit 2.5 MHz	3.00	TMS-6011	(TI)	6.95	2112A-4	256 x 4 Bit 450 ns TS (16 pin)	3.00
STATIC			SUPPORT DEVICES			2501B	256 x 1 Bit 1 us	1.45
MM506	100 x 2 Bit	.89	3851	Program Storage Unit (F-8)	14.95	3107	256 x 1 Bit 80 ns OC	2.95
2509K	50 x 2 Bit 1.5 MHz	1.00	3853	Static Memory Interface (F-8)	14.95	4200A	4096 x 1 Bit 250 ns	13.75
2518B	32 x 6 Bit 2.0 MHz	3.95	3881	Parallel I/O Controller (Z-80)	15.95	74C89	16 x 4 Bit 280 ns TS	3.00
2533V	1024 x 1 Bit 1.5 MHz	2.00	3882	Counter Timer Circuit (Z-80)	15.95	74S201	256 x 1 Bit 50 ns TS	4.75
TMS3002	50 x 2 Bit 1.0 MHz	1.00	TMS5501	I/O Controller	24.99	91L02A	1024 x 1 Bit 500 ns TS	2.00
TMS3112	32 x 6 Bit 2.0 MHz	3.95	8212	8-Bit I/O Port	4.25	7489	16 x 4 Bit 60 ns OC	2.25
MM5058	1024 x 6 Bit 1.5 MHz (8 pin)	2.00	8214	Priority Interrupt Control	12.95	8225	16 x 4 Bit 50 ns OC	1.50
			8216	Bi-Directional Bus Driver	5.25	8599	15 x 4 Bit 50 ns TS	1.50
			8224	Clock, Generator & Driver	6.00	82S09	64 x 9 Bit	11.00
			8228	System Controller & Bus Driver	9.25	FIFO		
			8238	System Controller & Bus Driver	8.20	3341A	64 x 4 Bit 1.0 MHz	6.75
			8261	Programmable Communication Int	12.00			
			8255	Programmable Peripheral Interface	12.00			
			8257	Progr Direct Mem Access Control	12.00			
			8259	Programmable Interrupt Controller	22.00			

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- DIP switch selection of memory address assignment and wait cycles.
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- T.I. low profile sockets provided for all RAMs and ICs.
- Gold plated edge connector contacts.

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10	Dual 156 WW Gold	50
15	Dual 156 WW Gold	75
22	Dual 156 Solder Gold	2.25
50	Dual 156 Solder Gold	.00
50	Dual 129 Solder Gold (for MM506)	.00
50	Dual 156 Solder Gold (for Altair)	.00

SUBMINUTURE CONNECTORS FOR RS232

25	Solder Type DB25 (D) (Male)	1.90
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	Male & Female (25 P & 25 S)	6.50
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10	Transistor IC 10 Gold	25
14	Lo Pin Tin	25
14	Wire-Wrap Gold	30
16	Lo Pin Tin	25
16	Standard P.C. Tin	30
16	Wire-Wrap Tin	30
18	Lo Pin Tin	25
18	Wire-Wrap Tin	85
20	Wire-Wrap Tin	95
22	Lo Pin Open (Land) Tin	50
22	Wire-Wrap Tin	95
24	Standard P.C. Tin	50
24	Wire-Wrap Tin	85
24	Lo Pin (Open Frame) Tin	40
28	Lo Pin (Open Frame) Tin	40
28	Standard P.C. Tin	60
30	Wire-Wrap Tin	95
40	Lo Pin (Open Frame) Tin	1.00
40	Wire-Wrap Tin	1.00

CRYSTALS			
Part #	Frequency	Case Style	Price
CY1A	1 000 MHz	HC33-U	\$5.95
CY2A	2 000 MHz	HC33-U	\$5.95
CY2 01	2 010 MHz	HC33-U	\$1.95
CY3A	4 000 MHz	HC18-U	\$4.95
CY7A	5 000 MHz	HC18-U	\$4.95
CY12A	10 000 MHz	HC18-U	\$4.95
CY14A	14 318.18 MHz	HC18-U	\$4.95
CY19A	18 000 MHz	HC18-U	\$4.95
CY22A	20 000 MHz	HC18-U	\$4.95
CY30B	32 000 MHz	HC18-U	\$4.95

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WAVEFORM GENERATORS		TIMERS	
XR-205	\$8.40	XR-555CP	\$3.99
XR-2206CP	4.49	XR-320P	1.55
XR-2207CP	3.85	XR-556CP	1.85
STEREO DECODERS		PHASE LOCKED LOOPS	
XR-1310CP	\$3.20	XR-4136	99
XR-1310EP	3.20	XR-1468	3.85
XR-1800P	3.20	XR-1488	5.80
XR-2567	2.99	XR-1489	4.80
		XR-567CP	1.95
		XR-567CT	1.70

CONNECTORS			
PRINTED CIRCUIT EDGE-CARD			
156 Spacing-Tin-Double Lead-Out			
Bifurcated Contacts — Fits 054 to 070 P.C. Cards			
15/30	PINS (Solder Eyelet)		\$1.95
18/36	PINS (Solder Eyelet)		\$2.49
22/44	PINS (Solder Eyelet)		\$2.95
50/100	PINS (Wire Wrap)		\$6.95
50/100A (100 Spacing)	PINS (Wire Wrap)		\$6.95
25 PIN-D SUBMINATURE			
DB25P	PLUG		\$3.25
DB25S	SOCKET		\$4.95

HEAT SINKS			
205-CB			680-75A
205-CB	Beryllium Copper w-black finish for T0-5		\$.25
291-36H	Aluminum for T0-220 Transistors & Regulators		\$.25
680-75A	Black Anodized Aluminum for T0-3		\$1.60
401-A	Black Anodized Aluminum — predrilled mounting holes for T0-3 — 4 1/4 x 1 1/4 x 2"		\$1.75

DIP SWITCHES			
	SPST Slide Action		
#206-4 (8 pin dip)	4 switch unit		\$1.75 ea.
#206-7 (14 pin dip)	7 switch unit		\$1.95 ea.
#206-8 (16 pin dip)	8 switch unit		\$2.25 ea.

Etching Kits			
32 X A-1	P.C. Etch Materials Kit enough for 5 circuit boards		\$29.95 ea.
27 X A-1	Etched Circuit Kit Complete kit — only add water		\$ 9.95 ea.
3662	6.5 X 4.5 X 1/16 Epoxy glass P-Pattern-44 P.C. Tabs-splined 156		\$ 6.95 ea.
22/44	Mating connector for plugboard — 22 pin double readout		\$ 2.95 ea.
8800V	Universal Microcomputer/Processor plugboard — Epoxy Glass — complete with heatsink and mounting hardware 5 3/16 X 10 X 1/16 copper clad		\$19.95 ea.

1/16 VECTOR BOARD			
0.1" Hole Spacing	P-Pattern	L	W
PHENOLIC	Part No.	1	2 Up
	63P44 062XXP	4.50	6.50 1.72 1.54
	169P44 02XXP	4.50	17.00 3.69 3.02
EPOXY GLASS	64P44 062	4.50	6.50 2.01 1.66
	84P44 062	4.50	8.50 2.56 2.21
	169P44 062	4.50	17.00 5.04 4.51
	169P44 062	8.50	17.00 9.23 8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00 6.80 6.12

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• Slits and opens insulation exposing bare wire			
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• Comes complete with two - 100 ft spools #28 AWG wire			
Model P180			\$24.50

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• ABCDEF			
• Return Key			
• Optional Key (Period)			
• Key			
Model P180			\$10.95 each

63 KEY KEYBOARD			
This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13 x 4 base suits most applications			
HD0185 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER CHIP			\$7.95

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A97MS	Diagonal Cutter - 4" semi-flush cut		\$8.50 ea.
A11DMS	Chain Nose Pliers - 4 1/4" long		7.50 ea.
T-6	Wire Stripper - #16 to #26 gauge		3.75 ea.
55B	Wire Stripper - #10 to #20 gauge		2.50 ea.
CS-8	Cutter-Crimper Tool - 8 1/4" long		8.50 ea.
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212	8 Bit Input/Output	4.95	MC6800	8 Bit MPU	22.50	
214	Priority Interrupt Control	15.95	MC6820	Periph. Interface Adapter	15.00	
216	Bi-Directional Bus Driver	6.95	MC6810A P1	128 x 8 Static RAM	6.00	
224	Clock Generator/Driver	10.95	MC6830L8	1024 x 8 Bit ROM	18.00	
CDP1802	- with user manual	39.95	Z80	CPU	49.95	
CPU \$			RAM \$			
80	Super 8008A	21.95	1101	256 x 4	Static	\$ 1.49
800A	Super 8008A	19.95	2101	256 x 4	Static	5.95
8080	8 BIT MPU	26.50	2102	1024 x 1	Static	1.75
			2103	5280	4096 x 1	4.95
SR \$			7111	256 x 4	Static	6.95
504	1024 Dynamic	7.00	7489	16 x 4	Static	2.49
518	hex 32 B I	7.00	8101	256 x 4	Static	6.95
519	hex 40 B I	4.00	8111	256 x 4	Static	6.95
524	512 Dynamic	2.49	8599	16 x 4	Static	3.39
525	1024 Dynamic	6.00	91102	1024 x 1	Static	2.25
527	Dual 256 Bit	6.95	1200	256 x 1	Static	6.95
529	Dual 512 Bit	6.00	13421	256 x 1	Static	2.95
532	Quad 80 Bit	3.95	MS5282	2K x 1	Dynamic	2 for 1.00
533	1024 Static	9.95				
536	Spec'd	6.95	PRDMS			
541	Fifo	6.95	1702A	2048	Famos	\$ 9.95
134610	16 x J Reg	3.95	5203	2048	Famos	14.95
UART \$						
AY 5-1013	30K Baud	\$5.95	82523	32 x 8	Open C	5.00
			895121	32 x 8	Trans	5.00
			143281	7102	State	7.95
			3601	256 x 4	Fast	3.95
ROM \$			EPROM			
331240	Char Gen -upper case	\$ 9.95	2708	8K	Eprom	29.95
3312021	Char Gen -lower case	9.95	6301-1	1024	Tri-Static Bipolar	3.95
2516	Char Gen	10.95	6330-1	256	Open Collector Bipolar	2.95
			6331-1	256	Tri-Static Bipolar	2.95

SPECIAL REQUESTED ITEMS			
FCM3817	\$ 5.00	AY-3-8500-1	\$13.95
AY-3-8500-1	\$13.95	CD4508	6.75
MC3061P	3.50	CD4515	6.50
MC4016P (74416)	7.50	CD4520	2.70
MC14583	3.50	CD4520	11.50
MC14582	14.50	MC68571	17.50
CD4059	9.95	MC68574	17.50
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	QT-125
	QT-85
	QT-75

QT type	#holes	price
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1N4004	400v	1A	.08	14-pin	pcb	.25	ww	.40	2N2907	PNP		.15	
1N4005	600v	1A	.08	16-pin	pcb	.25	ww	.40	2N3740	PNP	1A 60v	.25	
1N4007	1000v	1A	.15	18-pin	pcb	.25	ww	.75	2N3906	PNP		.10	
1N4148	75v	10mA	.03	22-pin	pcb	.45	ww	1.25	2N3054	NPN		.35	
1N753A	6.2v	z	.25	24-pin	pcb	.35	ww	1.25	2N3055	NPN	15A 60v	.50	
1N758A	10v	z	.25	28-pin	pcb	.35	ww	1.45	T1P125	PNP	Darlington	.35	
1N759A	12v	z	.25	40-pin	pcb	.50	ww	1.95	LED Green, Red, Clear			.15	
1N4733	5.1v	z	.25	Molex pins	.01	To-3 Sockets		.25	D.L.747	7 seg 5/8" high com-anode		1.95	
1N5243	13v	z	.25	2 Amp Bridge		100-prv		1.20	XAN72	7 seg com-anode		1.50	
1N5244B	14v	z	.25	25 Amp Bridge		200-prv		1.95	FND 359	Red 7 seg com-cathode		1.25	
1N5245B	15v	z	.25										

C MOS				- T T L -							
4000	.15	7400	.15	7473	.25	74176	1.25	74H72	.55	74S133	.45
4001	.20	7401	.15	7474	.35	74180	.85	74H101	.75	74S140	.75
4002	.20	7402	.20	7475	.35	74181	2.75	74H103	.75	74S151	.35
4004	3.95	7403	.20	7476	.30	74182	.95	74H106	.95	74S153	.35
4006	1.20	7404	.15	7480	.55	74190	1.75			74S157	.80
4007	.35	7405	.25	7481	.75	74191	1.35			74S158	.35
4008	1.20	7406	.35	7483	.95	74192	1.65	74L00	.35	74S194	1.05
4009	.30	7407	.55	7485	.95	74193	.85	74L02	.35	74S257(8123)	.25
4010	.45	7408	.25	7486	.30	74194	1.25	74L03	.30		
4011	.20	7409	.15	7489	1.35	74195	.95	74L04	.35		
4012	.20	7410	.10	7490	.55	74196	1.25	74L10	.35	74LS00	.45
4013	.40	7411	.25	7491	.95	74197	1.25	74L20	.35	74LS01	.45
4014	1.10	7412	.30	7492	.95	74198	2.35	74L30	.45	74LS02	.45
4015	.95	7413	.45	7493	.40	74221	1.00	74L47	1.95	74LS04	.45
4016	.35	7414	1.10	7494	1.25	74367	.85	74L51	.45	74LS05	.55
4017	1.10	7416	.25	7495	.60			74L55	.65	74LS08	.45
4018	1.10	7417	.40	7496	.80			74L72	.45	74LS09	.45
4019	.70	7420	.15			75108A	.35	74L73	.40	74LS10	.45
4020	.85	7426	.30			75110	.35	74L74	.45	74LS11	.45
4021	1.35	7427	.45	74100	1.85	75491	.50	74L75	.55	74LS20	.40
4022	.95	7430	.15	74107	.35	75492	.50	74L93	.55	74LS21	.25
4023	.25	7432	.30	74121	.35			74L123	.55	74LS22	.25
4024	.75	7437	.35	74122	.55					74LS32	.40
4025	.35	7438	.35	74123	.55	74H00	.25			74LS37	.40
4026	1.95	7440	.25	74125	.45	74H01	.25	74S00	.55	74LS40	.55
4027	.50	7441	1.15	74126	.35	74H04	.25	74S02	.55	74LS42	1.75
4028	.95	7442	.55	74132	1.35	74H05	.25	74S03	.40	74LS51	.65
4030	.35	7443	.85	74141	1.00	74H08	.35	74S04	.35	74LS74	.75
4033	1.95	7444	.45	74150	1.00	74H10	.35	74S05	.35	74LS86	.75
4034	2.45	7445	.80	74151	.75	74H11	.25	74S08	.35	74LS90	1.30
4035	1.25	7446	.95	74153	.95	74H15	.30	74S10	.35	74LS93	1.00
4040	1.35	7447	.95	74154	1.05	74H20	.30	74S11	.35	74LS107	.95
4041	.69	7448	.95	74156	1.15	74H21	.25	74S20	.35	74LS123	1.00
4042	.95	7450	.25	74157	.65	74H22	.40	74S40	.25	74LS151	.75
4043	1.25	7451	.25	74161	.85	74H30	.25	74S50	.25	74LS153	1.20
4044	.95	7453	.20	74163	.95	74H40	.25	74S51	.45	74LS157	.85
4046	1.50	7454	.25	74164	.60	74H50	.25	74S64	.25	74LS164	1.90
4049	.80	7460	.40	74165	1.50	74H51	.25	74S74	.40	74LS367	.85
4050	.60	7470	.45	74166	1.35	74H52	.15	74S112	.90	74LS368	.70
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COMPUTER VIDEO MONITOR

A few months ago we advertised a limited quantity of 12" VIDEO MONITORS. We sold out in 2 days, as many of you know. We have now acquired another lot of 12" VIDEO MONITORS. These monitors are all in warranty returns to a large computer manufacturer. Rather than service these units, he replaced them with new units, and we acquired the lot. We have gone over them thoroughly, and guarantee them to be in working condition. We provide a 14 page service manual and wiring diagram. We also have a limited number of the metal cases and face masks that went with some of these units.

Some of the specifications are as follows: Signal input, Composite-video & sync, per RS 170, 1 to 2 volts p-p. sync polarity negative. Separate Vert. & Hor. Sync, 1 to 5 volts positive, can be changed to negative. Impedance, equivalent to 150K ohms, parallel with 15 pf. 75 ohm terminated. Video response, within 3 dB from 15 Hz to 15 Mhz. Resolution, center, 750, corner 650. Linearity, 1%. Picture Scan, 15,750 horiz. lines/sec. 47 to 63 Vert. pulses/sec. Horizontal retrace time 11 usec. max. Vertical retrace time, allow 21 scan lines per RS 170.

These monitors sold in excess of \$250.00 each in quantities of 100. An opportunity to get a quality monitor at surplus prices.



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There are 6 highly regulated voltages available, +5.0 volts @ 5.0 A., -5.0 volts @ 1.0 A., +15 volts @ 0.6A., -15 volts @ 0.6A., +14 Volts @ 2.0 A. and 200 Volts @ 0.036A. These supplies are limited in quantity. We supply data with each supply. 16"x4"x6". Wt. 15 lbs.

STOCK NO.5527K DYNAGE POWER SUPPLY \$34.50 2/62.00

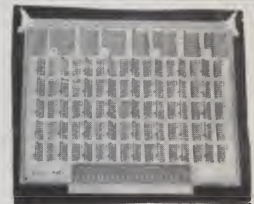
STEP UP/STEP DOWN ISOLATION TRANSFORMER

Hard to find step up or down isolation transformer. It will take either 208 or 230 volts, and give an output of 115 volts, or it will take an input of 115 volts, and give an output of either 208 or 230 volts. Rating is 800 VA. CRAMER catalog shows a STANCOR with 500 VA rating for \$94.19

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Wire wrap boards for prototyping or small run permanent work have been very expensive, with some boards running in excess of \$200.00 for some of the medium size boards. We have come up with a fantastic board, that brings this highly desirable device within the price range of the hobbyist user. The board we have is 7 1/4"x8" It has provision for 40 14 or 16 pin integrated circuits plus 4 24 pin LSI sockets. The LSI sockets are dual purpose, so that if not used, they may be used for 14 or 16 pin ICs. All the wire wrap pins are brought out to the top of the board, for simplicity in wire wrapping. The board has a ground plane, and a Vcc plane, with pins from each plane at every socket. There are 50 gold plated contacts on each side of the board, for use with a standard edge connector. The board is g 10 fiberglass, and each comes sealed in protective plastic. We just cant say enough about this board.



STOCK NO.6592K Gold plated prototype board \$24.50 ea. 2/45.00

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encies used in standard telephone systems to generate tones for touch tone pads, 1 high and 1 low frequency for each tone. The pad we offer is a mate to this chip. It is internally wired for this chip, and all that is needed is a source of power, 4.5 to 35 volts, and you get an

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STOCK NO.1019K Tone generator chip and Touch Tone pad 12.95 2/25.00 pages of data

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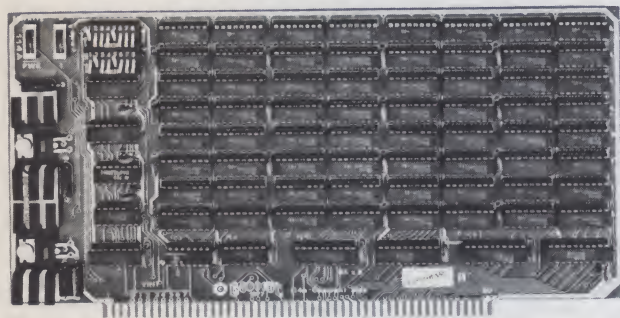
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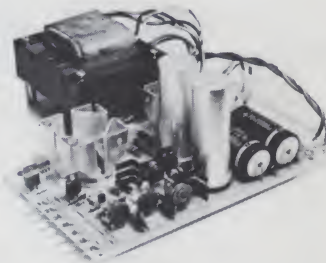
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...and a selection of S-100 compatible kits to match.



CPU power supply \$50

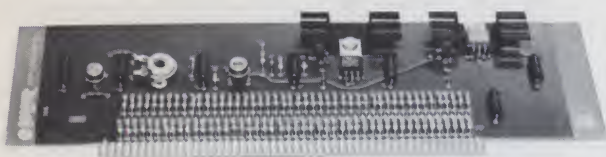


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8Kx8 Econoram IITM single kit \$163.84 3 kits-24K of memory!- \$450

Configured as two separate 4K blocks for maximum flexibility. Individual protect for each block; provides interrupt if write attempt is made into protected block. Buffered data in, address in, and outputs. Tri-state outputs. Guaranteed under 1.5A and faster than 450 ns. Use with 1 wait state (logic implemented on board) with 4 MHz Z-80. Writes on either PWR or MWRITE, your choice. Low power Schottky support ICs. Lots of bypass caps. Sockets for all ICs. Legended, solder masked double-sided board.

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\$1216 complete, Olivetti alone \$875, Potter line Filter \$25, Shipping additional

★ CWS5 CRT, Digital Tape Drive I/O, 16K IMSAI KIT



This is a top notch system and the Techtran Digital Cassette tape drive (90-day used gear warranted) really establishes the system for solid heavy use. The drive features ASCII RS232 interface, off-line on-line operation, 110 to 300 baud, automatic BOT/EOT operation, 70,000 character capacity, runs directly from terminal. Combined with the 16K Imsai is our popular Hazeltine 1000, 12 x 80 CRT display (90-day used gear warranted), 64 character ASCII, 32 ASCII control codes: 110, 300 baud. With the Imsai are 20 Viking sockets for the motherboard, serial I/O, 16K RAM and cable A.

\$2493 complete, Hazeltine 1000 alone \$695, Techtran Digital Tape alone \$595 & shipping

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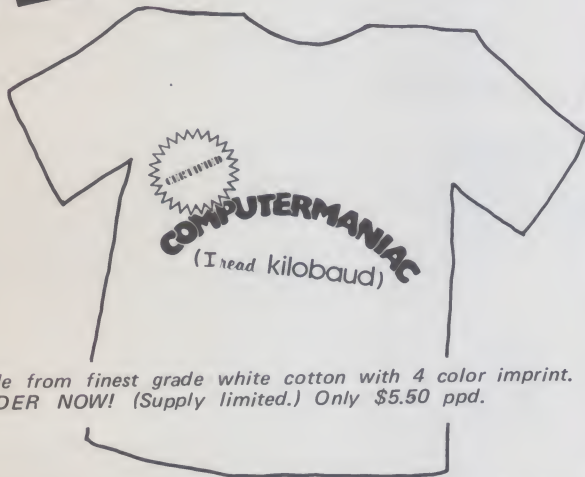
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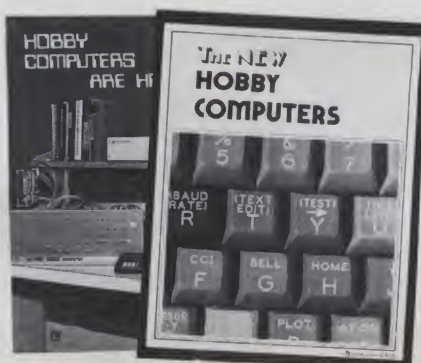
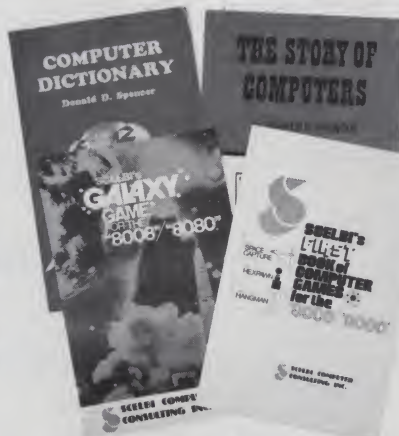
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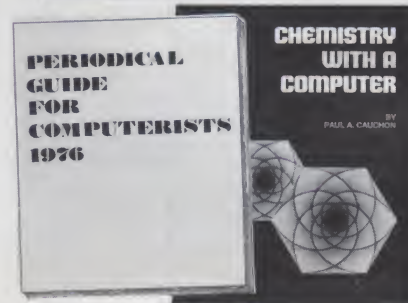
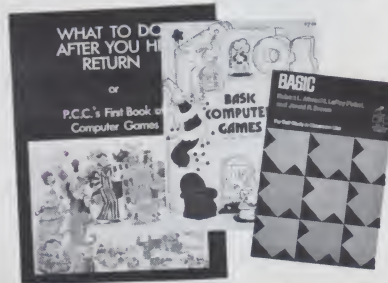
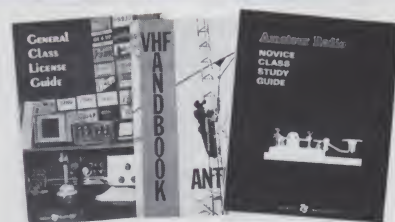
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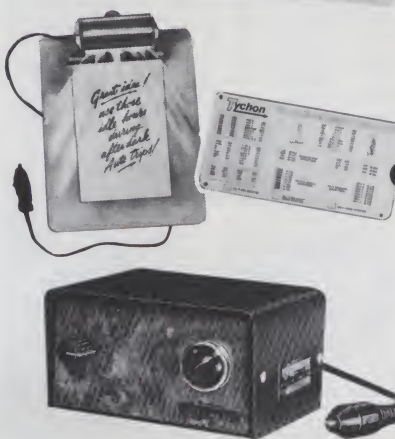
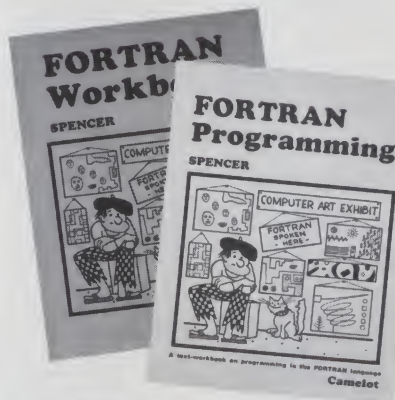
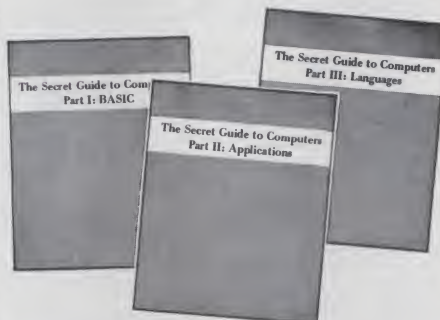
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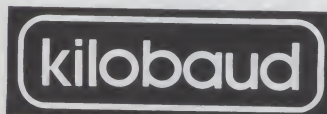
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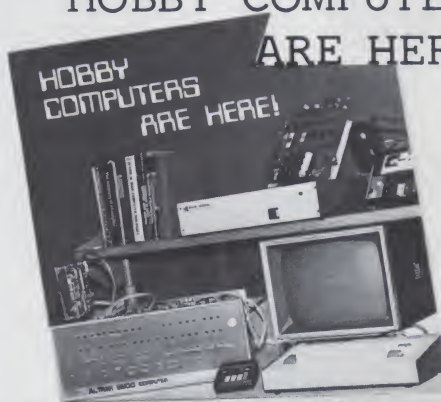
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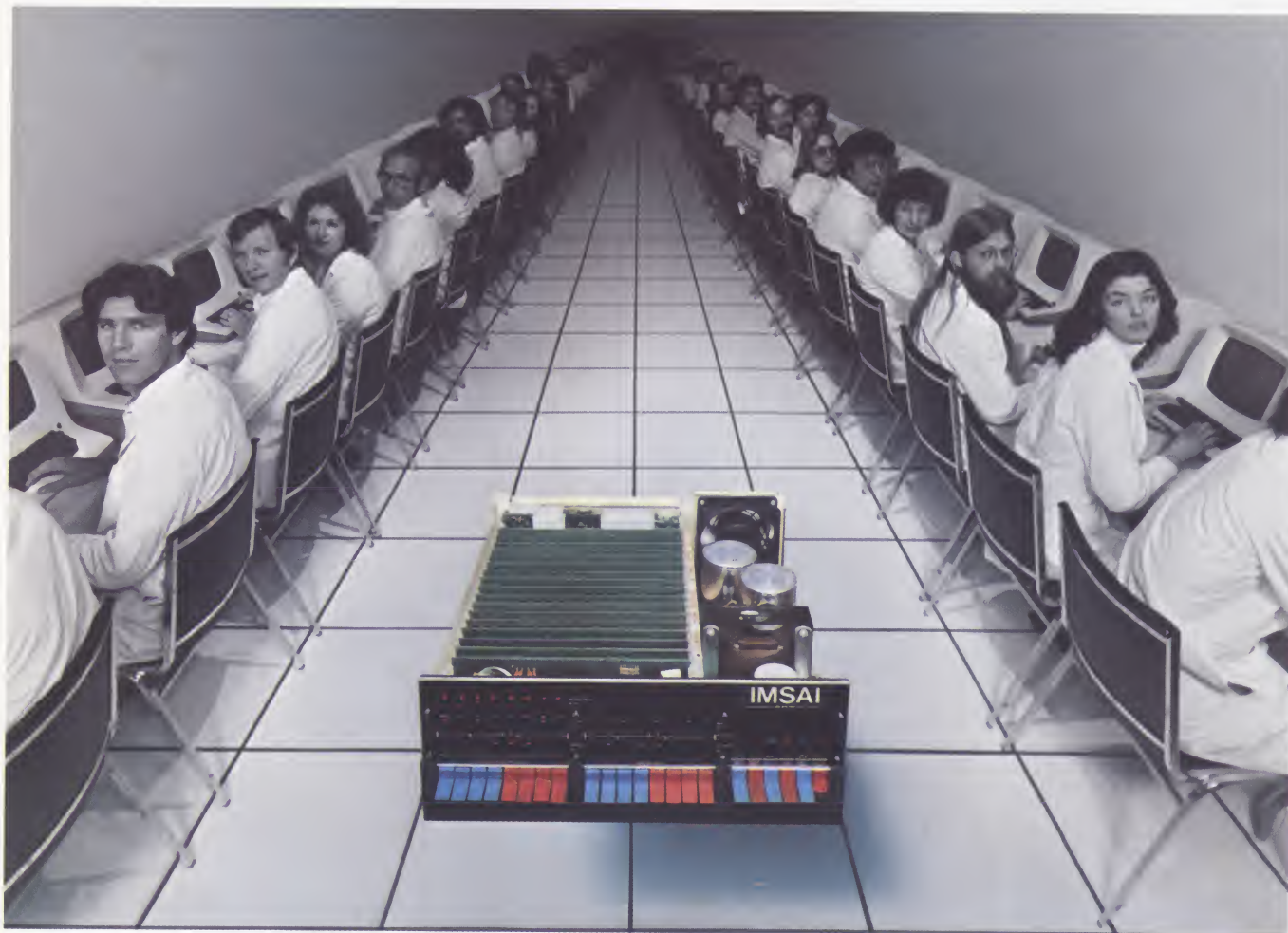
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All interrupts are fully vectored, and there's an interrupt if an attempt is made to write into protected memory.

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Until today, the most memory you could plug into a single slot was 16K.

Now, IMSAI presents memory boards in astonishing multiples of sixteen: 65K, 32K and 16K low power, dynamic RAM Boards. They can be used in any S-100 bus computer individually or in combination to form conventional systems up to 65K bytes.

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The IMSAI Megabyte Micro™ is only part of the story. The full system can include dual floppy disks, terminals, plotters, printers and tape cassettes.

IMSAI also offers the finest high level and peripheral software available. Paper tape and Tape Cassette I/O and super Disk Operating Systems. Plus, BASIC and Disk BASIC with more high level languages coming.

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Powerful in computing muscle, yet small in physical size, the Altair™ 680b offers many special features at an affordable price. Based on the 6800 microprocessor, the 680b comes with 1K of static RAM, Serial I/O port, PROM monitor and provisions for 1K of PROM as standard components. It's good thinking, when you're interested in making a modest investment on a highly reliable computer, to consider the Altair 680b.

Our PROM monitor eliminates the necessity for toggling front panel switches to load bootstraps or manipulate memory contents. Only a terminal and programming language are required for complete system operation. With Altair System software—Altair 680 BASIC, assembler and text editor—you may begin problem solving immediately with ease.

By adding the 680b-MB Expander card, many options are currently available:

*16K Static Memory Board—Increase your system memory with 16K bytes of fast access (215 ns), low power (5 watts per board) static RAM. 680 BASIC and assembler/text

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*Process Control Interface—A PC card that uses optically isolated inputs and relay outputs that transmit sensory information to and control signals from the computer. A diverse world of control applications is opened up with the Altair 680b-PCI.

*Universal Input/Output Board—If your I/O needs exceed the serial port already on the main board, augment your I/O channels with the 680b-UI/O. By implementing the optional serial port and two parallel ports, you can simultaneously interface to four terminals.

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Available in either full front panel or turnkey models, the Altair 680b presents many computing capabilities at a low cost—without skimping on performance. See it today at your local Altair Computer Center or contact the factory for further details.



Good Thinking.



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